Welcome!

Android Things
Spring 2024

Lecture #1
Introduction to IoT

Prerequisites

- Modern programming language
- Object oriented
- Statically types
- IDE - IntelliJ/Android Studio

What you should know...

- Basics:
  - Object-oriented programming
  - Classes, methods
  - Exception handling

Internet
of people

Internet
of things

Why

- Collect and aggregate data.
- Remote control devices.
- Automate certain tasks.

Image source: https://newsignature.com/articles/iot-now-eric-stein-new-signature-solutions-architect/

What

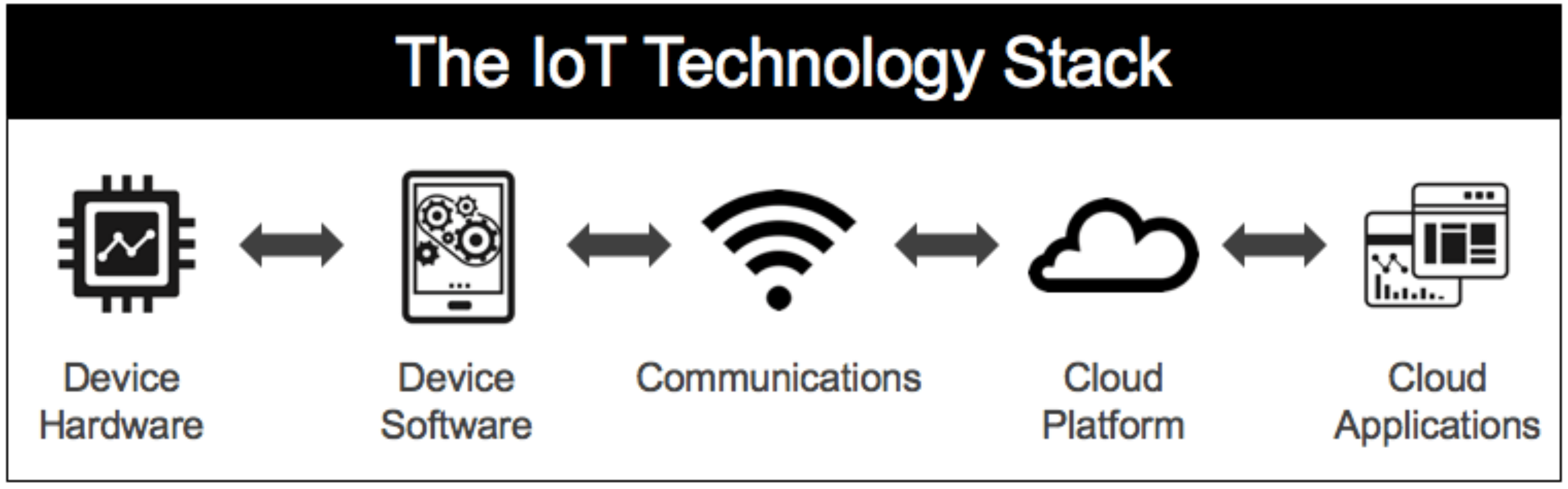
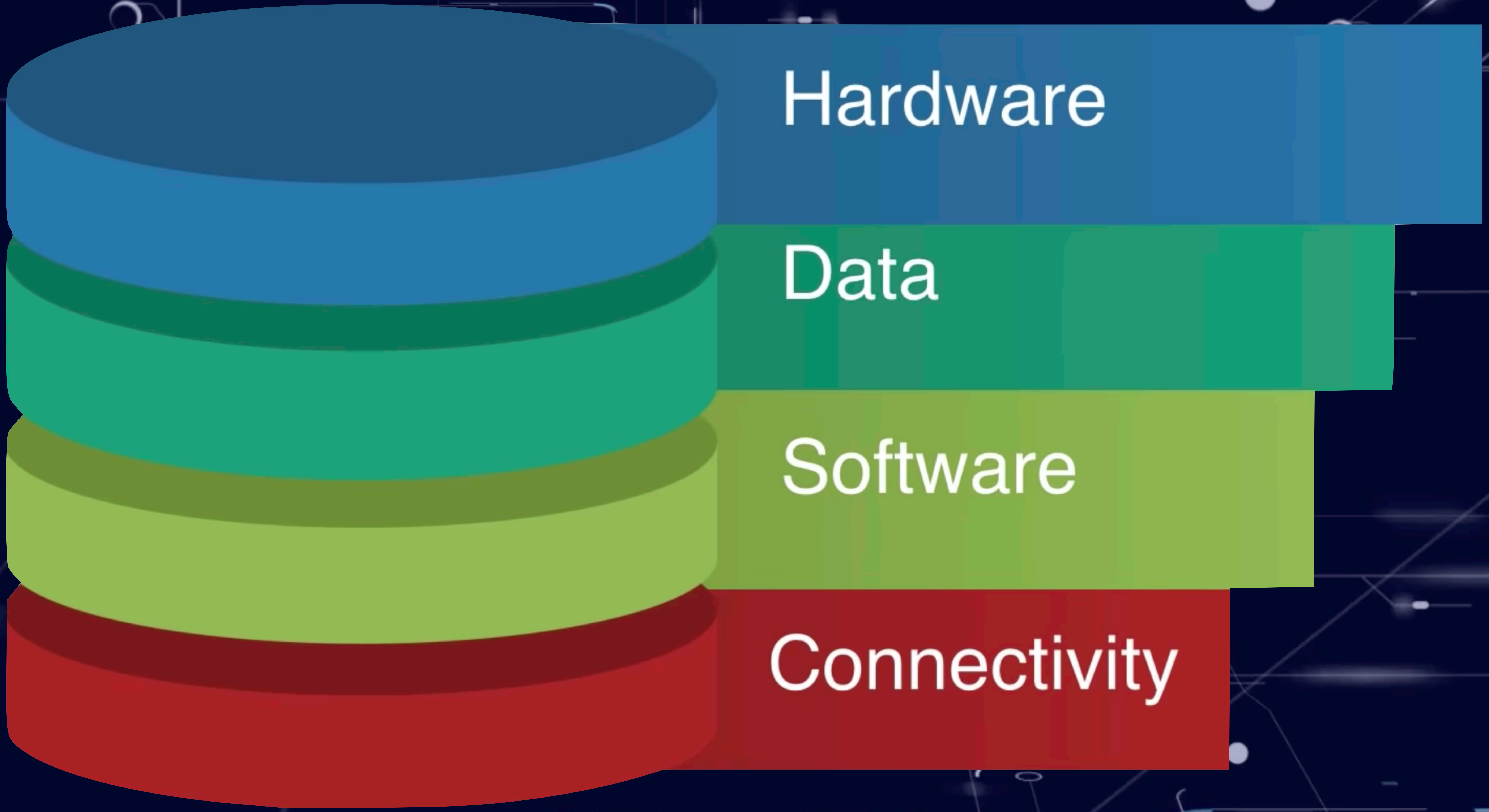


Image source: https://www.iotforall.com/iot-product-managers-guide-iot-technology-stack/

What

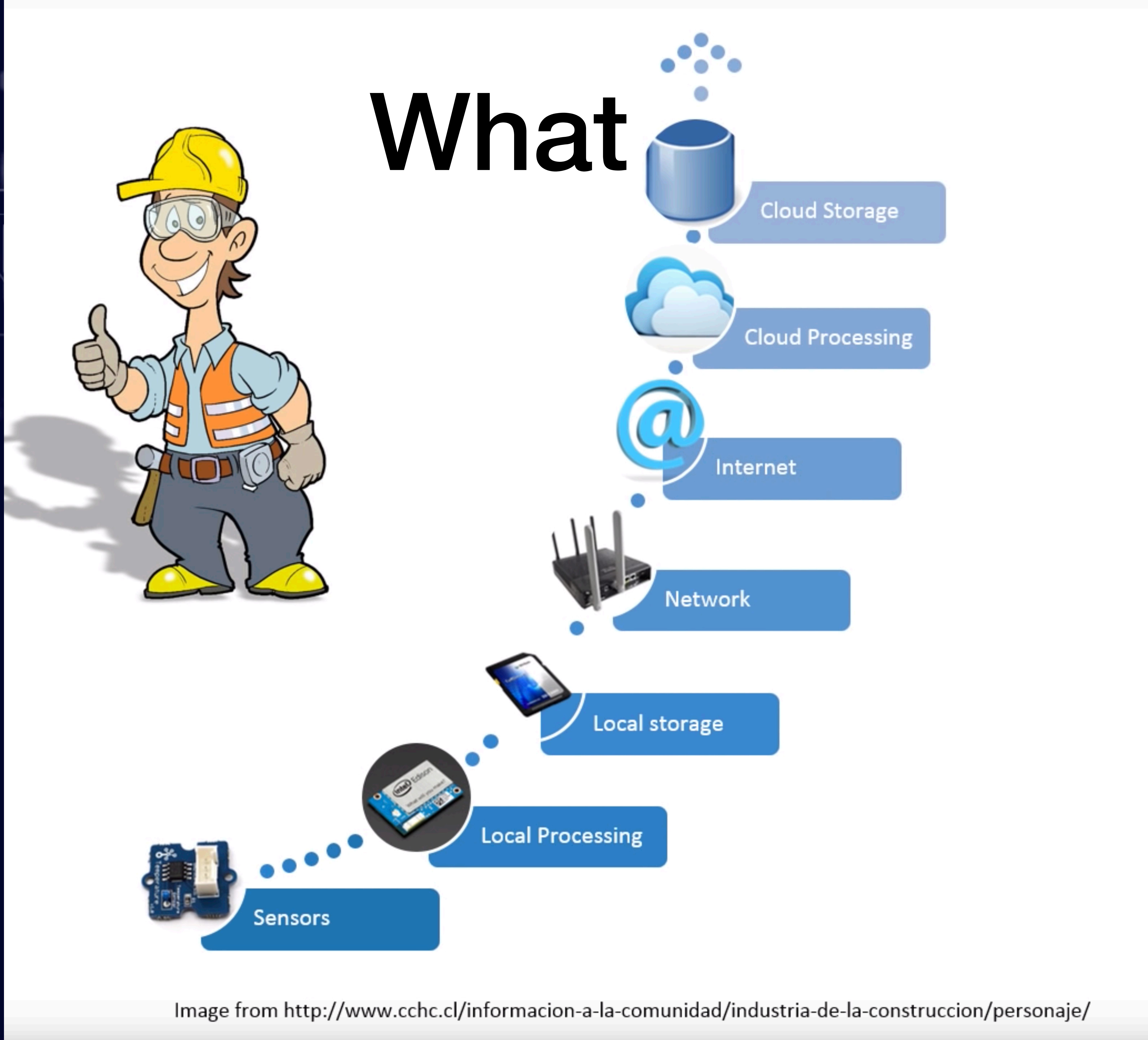


Hardware

Data

Software

Connectivity



What

Cloud Storage

Cloud Processing

Internet

Network

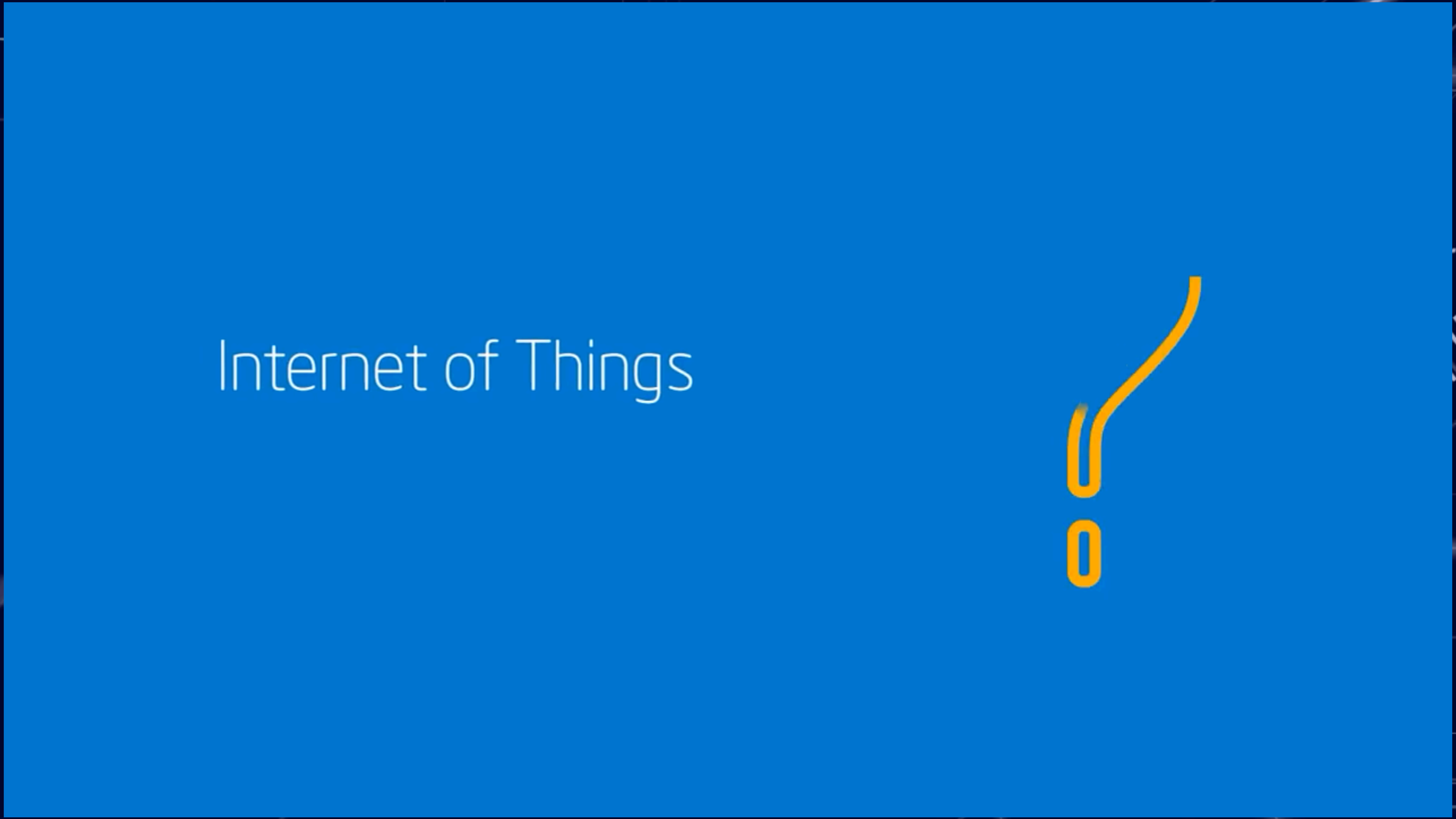
Local storage

Local Processing

Sensors

Image from http://www.cchc.cl/informacion-a-la-comunidad/industria-de-la-construccion/personaje/

What

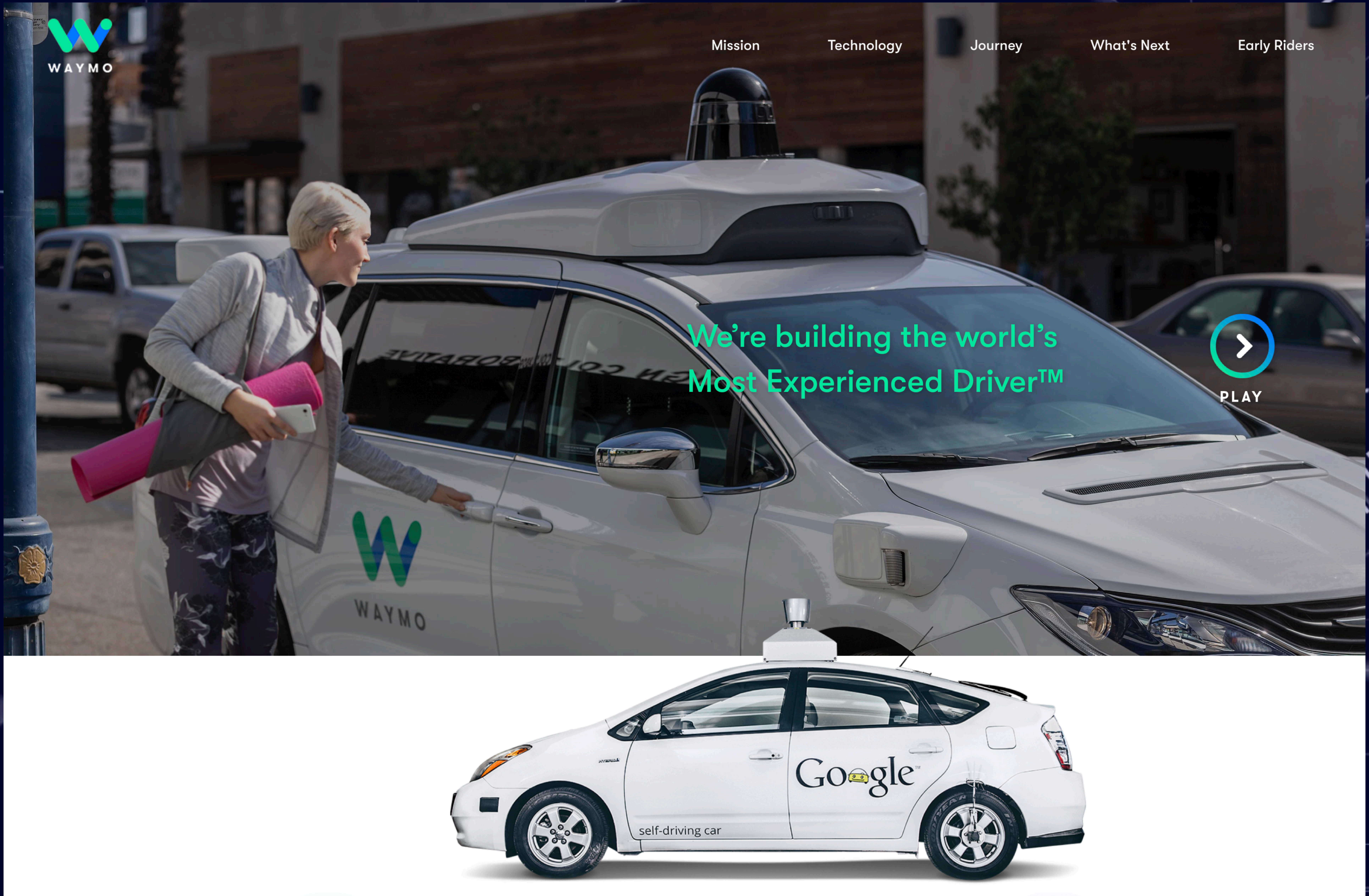


Internet of Things

https://www.youtube.com/watch?v=Q3ur8wzzhBU

https://www.youtube.com/watch?v=KECfgrw02fU

https://www.ratp.fr/en/groupe-ratp/engineering/fully-automated-century-old-metro-lines



We're building the world's
Most Experienced Driver™

https://waymo.com/

"The Internet of everything will have five to 10 times the impact on society as the Internet itself"

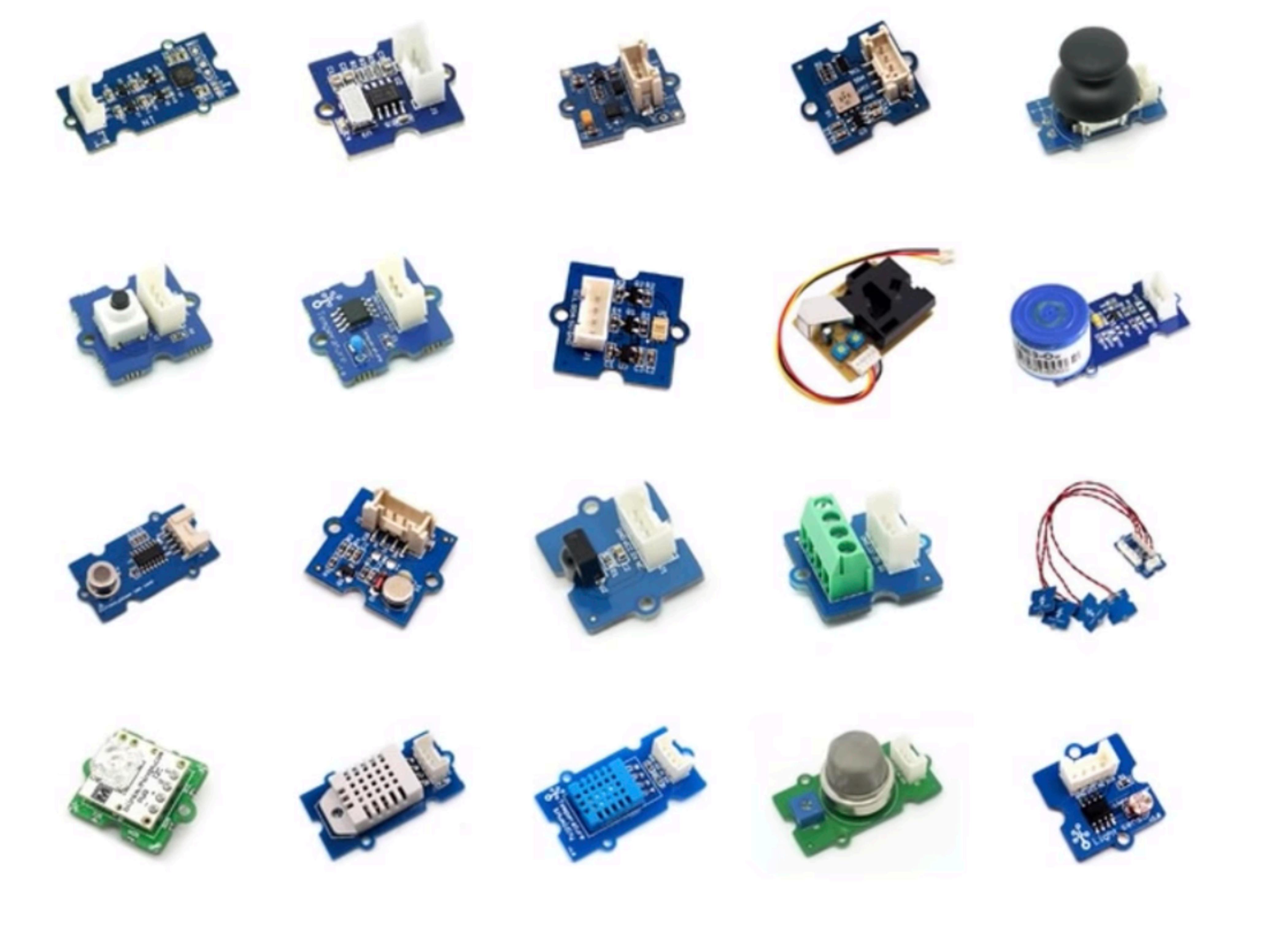
Cisco CEO John Chambers

$19 trillion in economic benefit and value over the next decade.

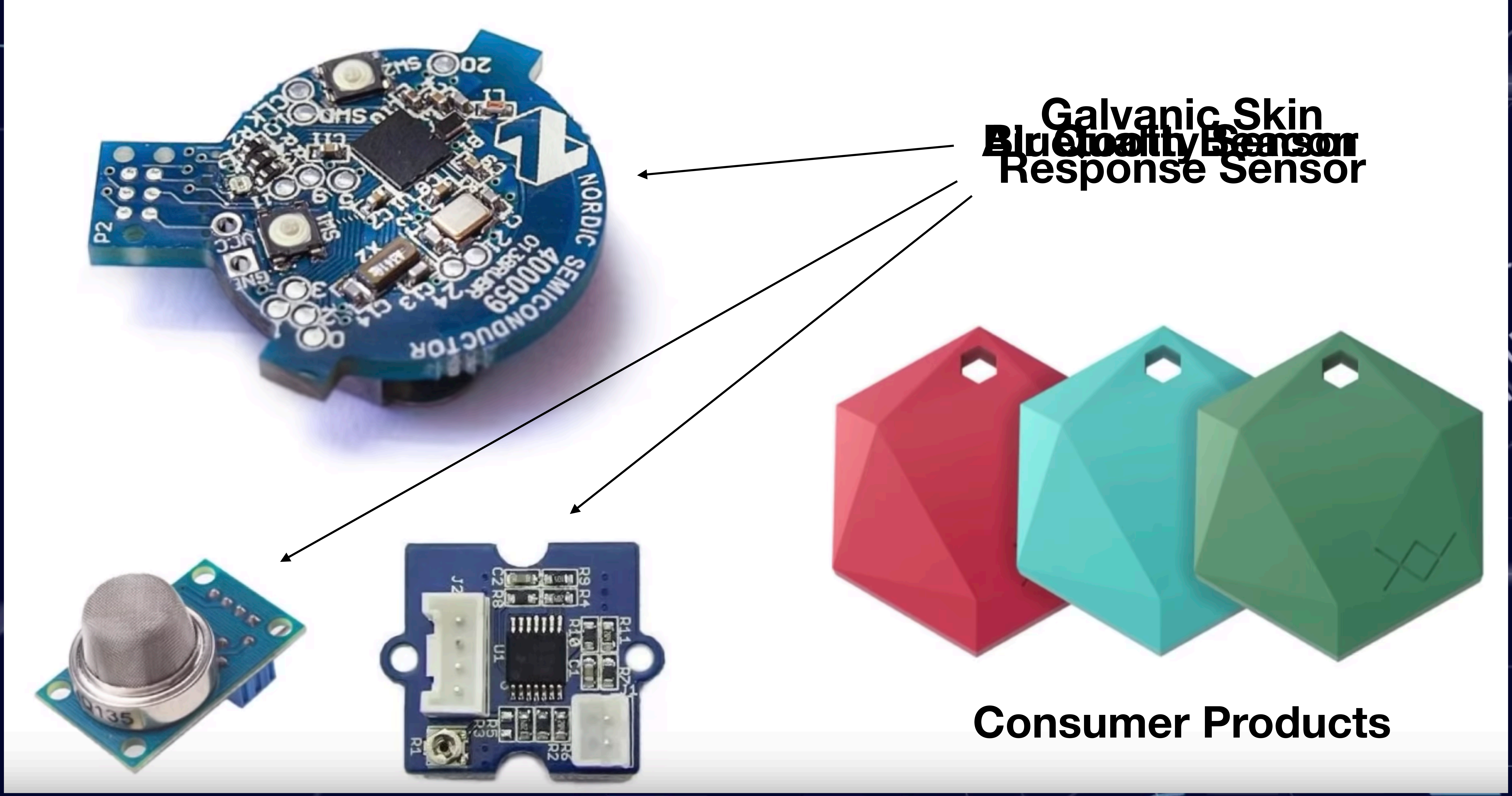
https://www.cnet.com/news/how-much-is-the-internet-of-everything-worth-cisco-says-19-trillion/

Sensors

- Measure values.
- Send raw data.
- Low power.
- Almost no maintenance needed.



Sensors



Galvanic Skin Response Sensor

Bluetooth Beacon

Air Quality Sensor

Consumer Products

Local Processing
Persistence

- Collects sensor data.
- Light processing.
- Uploads data to the cloud.

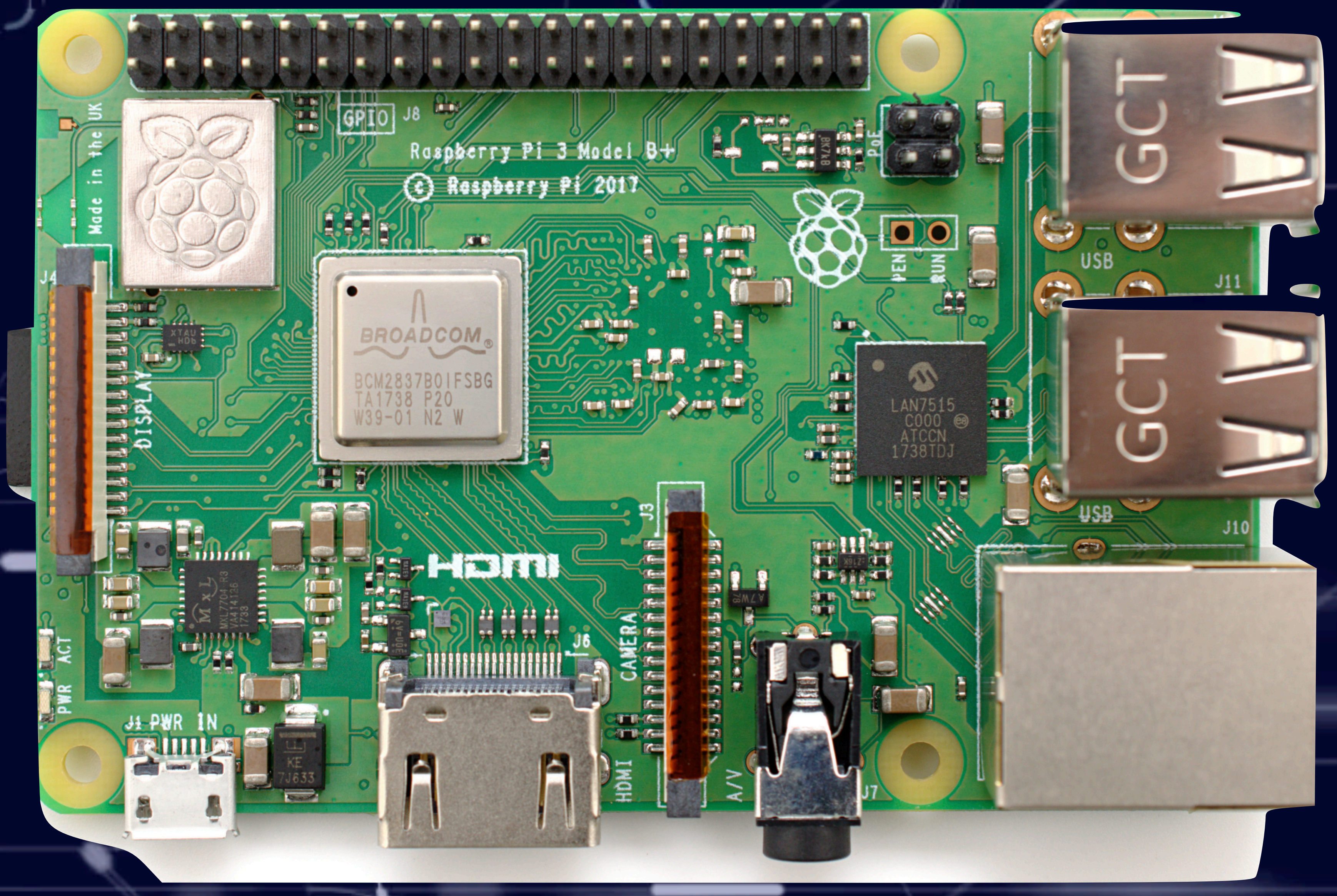


Image source: https://www.flickr.com/photos/120586634@N05/39906369025/

Edge/ Fog Computing

Network & Internet

- IoT Gateways.
- Connects multiple sensors and local processing units.
- Protocols:
  - CoAP http://coap.technology/
  - MQTT http://mqtt.org/
  - HTTP https://www.w3.org/Protocols/
  - XMPP https://xmpp.org

Image source: https://commons.wikimedia.org/wiki/File:Linksys-Wireless-G-Router.jpg

Cloud Processing & Storage

- Aggregate.
- Store.
- Analyze.
- Predict.

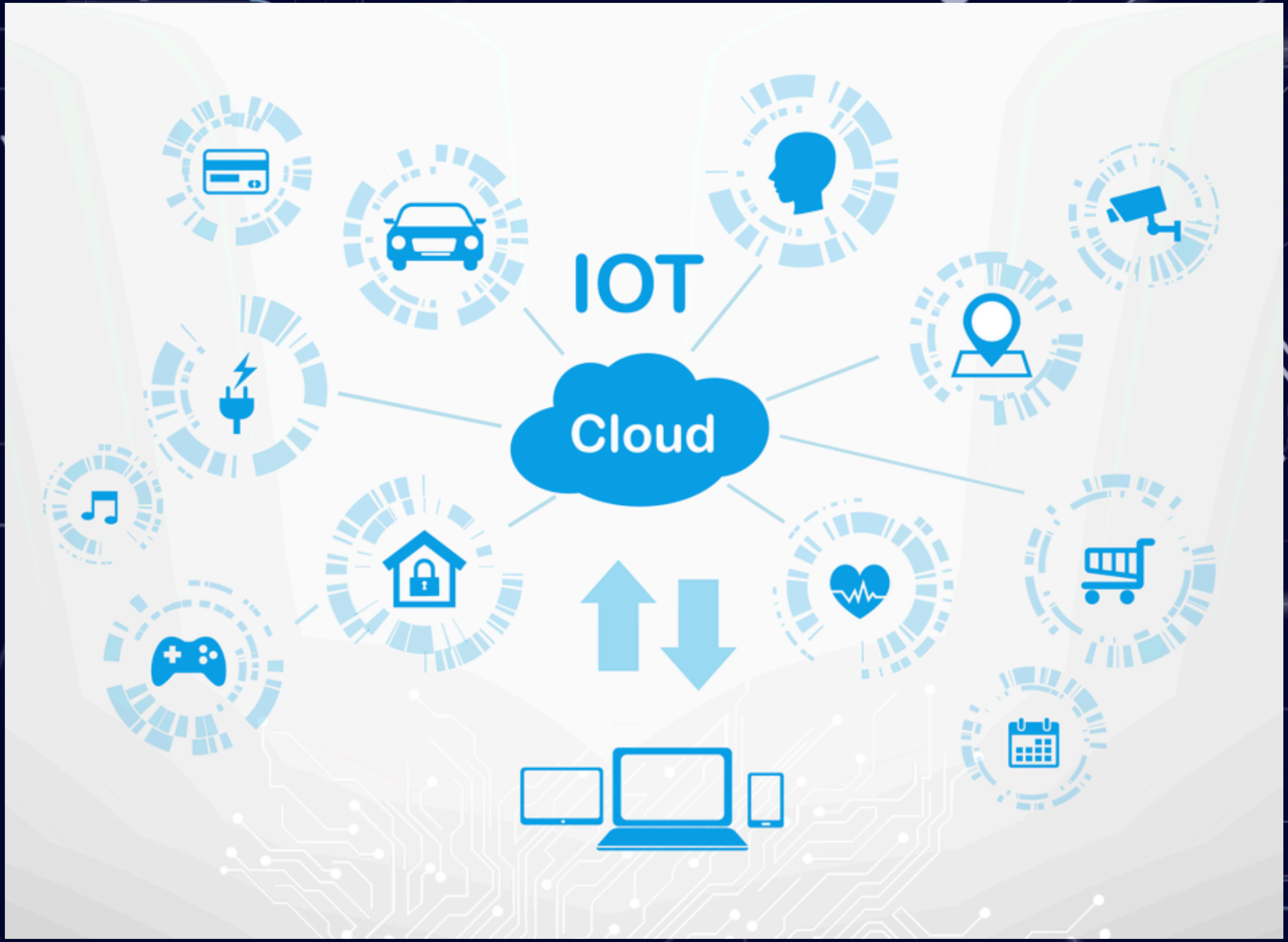


Image source: http://www.kritikalsolutions.com/cloud-iot-solutions

How it started

- August 26th, 1997
  - Bruce Perens
  - https://lists.debian.org/debian-announce/1997/msg00026.html

Image source: https://www.oshwa.org/open-source-hardware-logo/

1972

Microcontroller

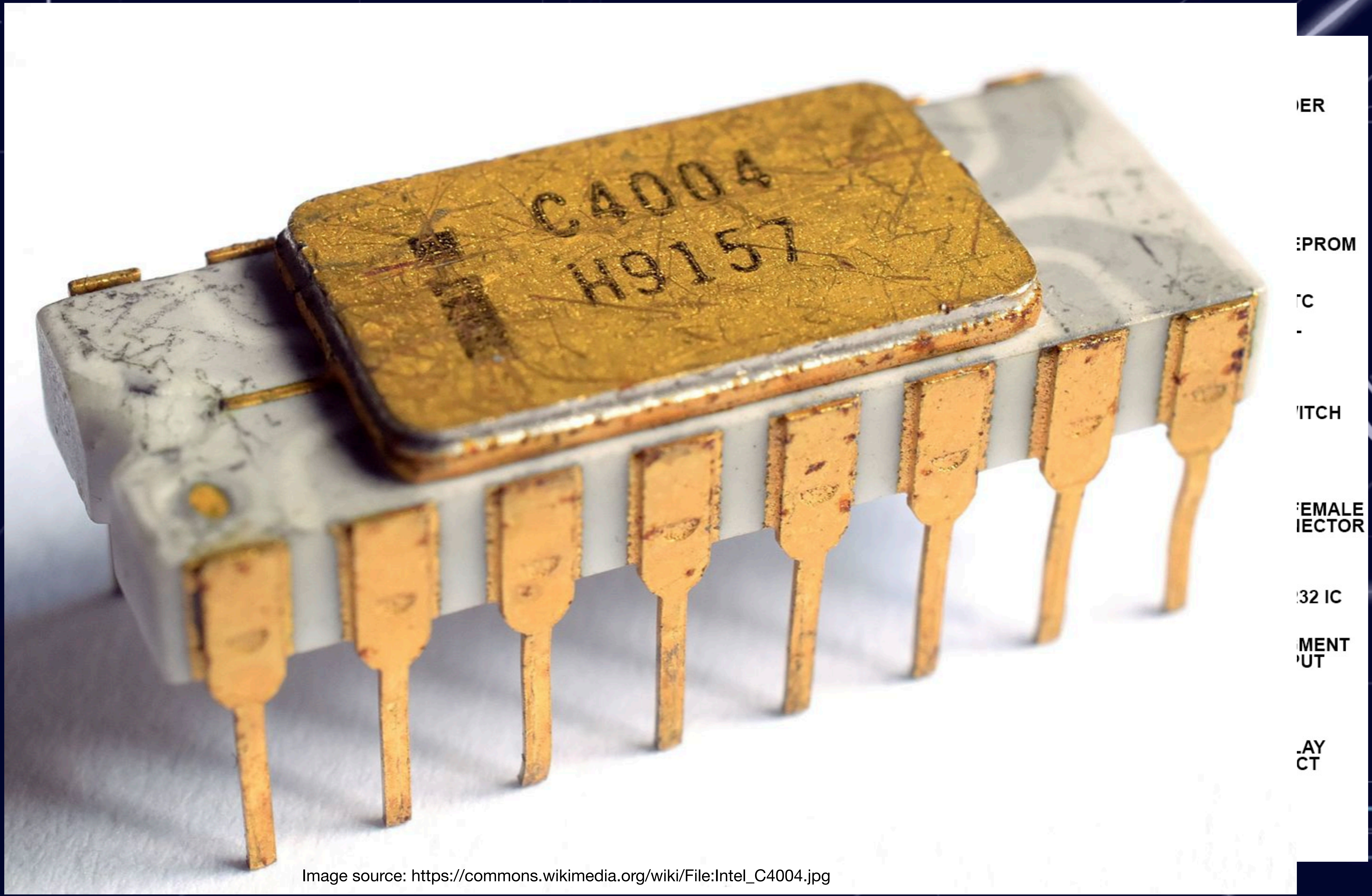


Image source: https://commons.wikimedia.org/wiki/File:Intel_C4004.jpg

1972 1982

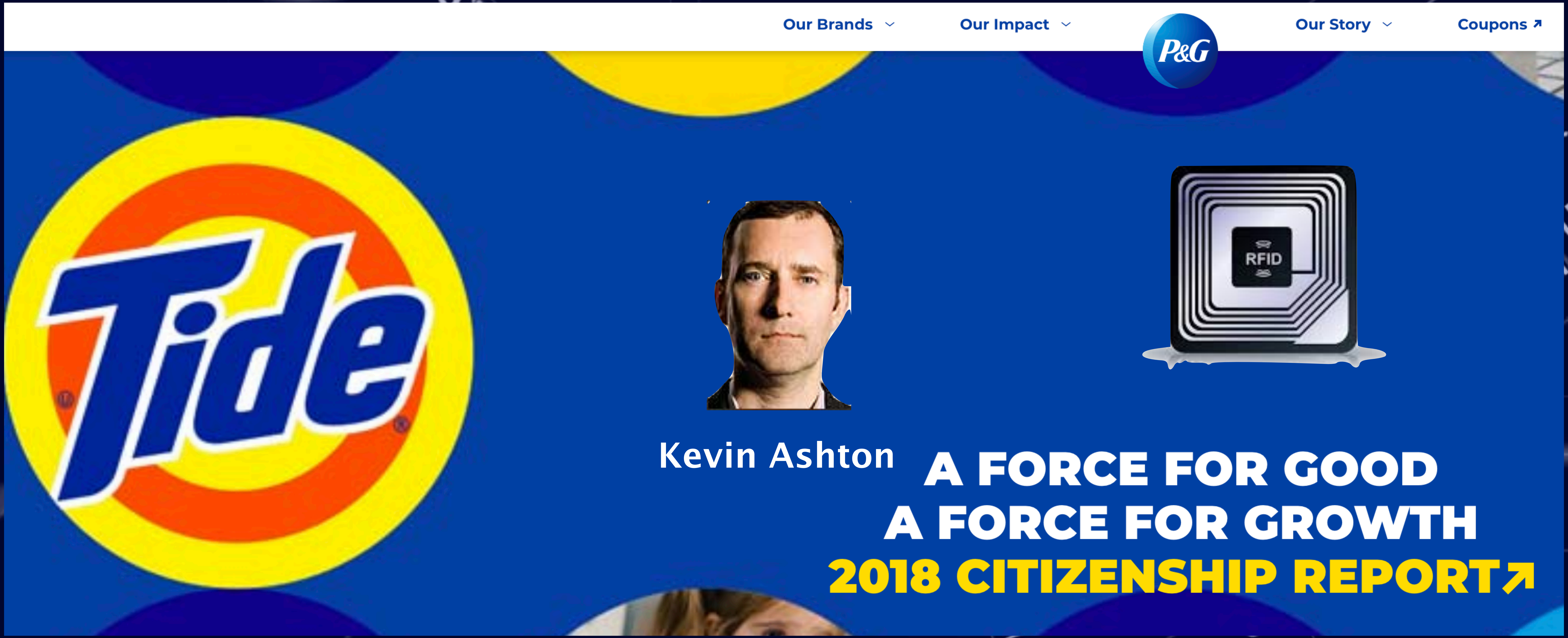
First Internet Connected Device

CMU's connected Coke machine

https://www.cs.cmu.edu/~coke/history_long.txt

1972
1982
1999

Internet of Things

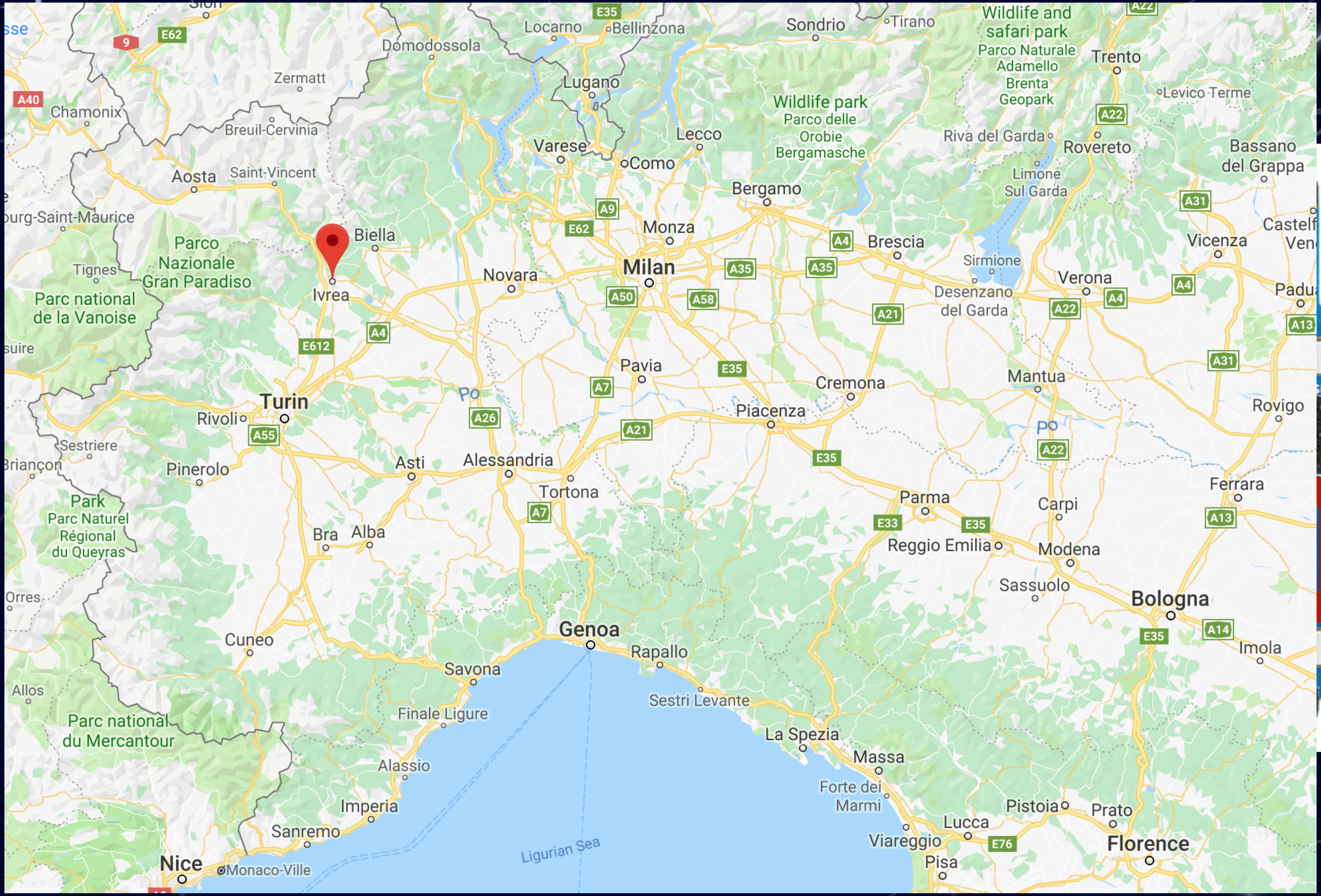


Kevin Ashton

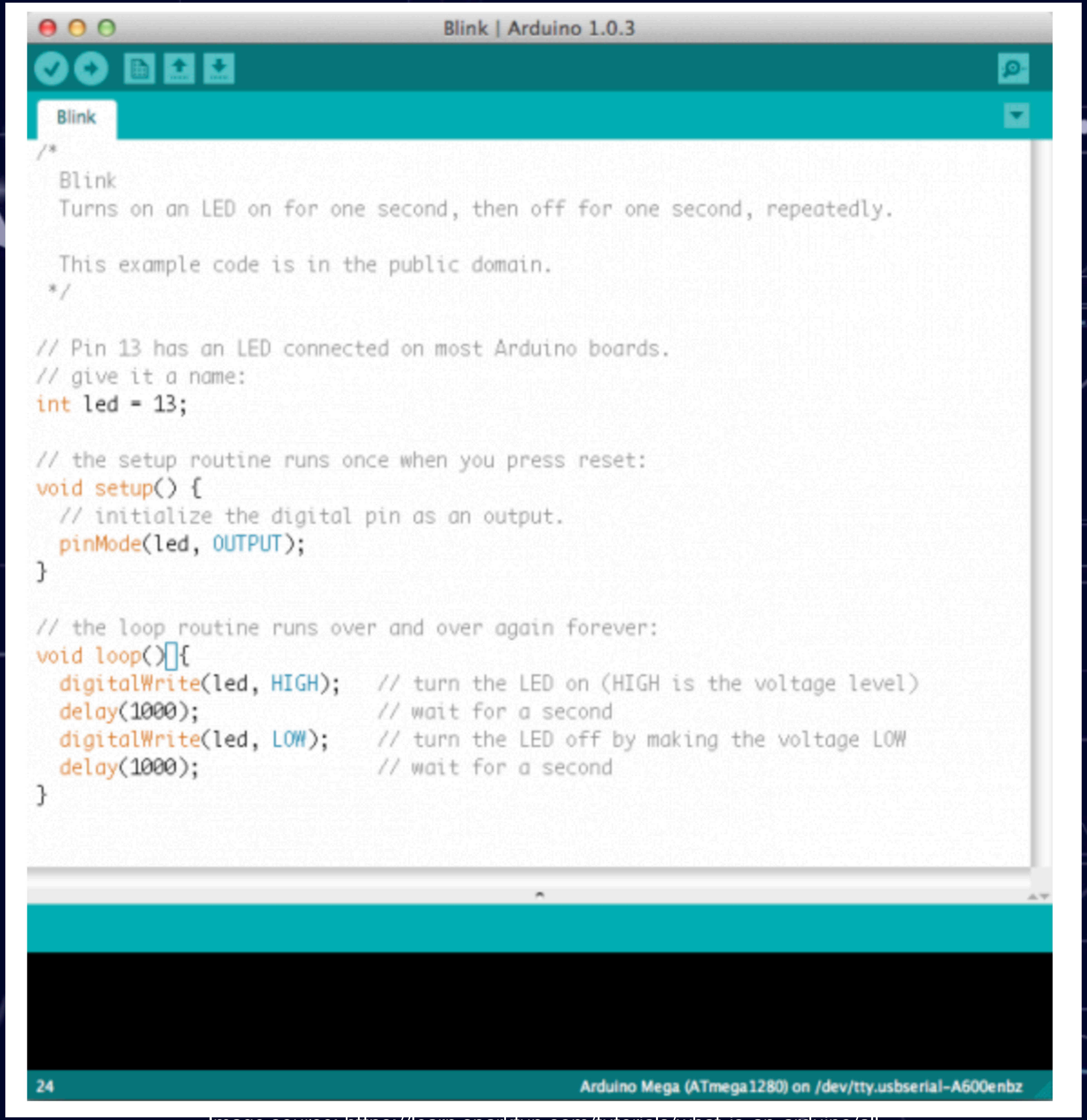
A FORCE FOR GOOD
A FORCE FOR GROWTH
2018 CITIZENSHIP REPORT↗

1972 1982 1999 2003

Arduino



Arduino



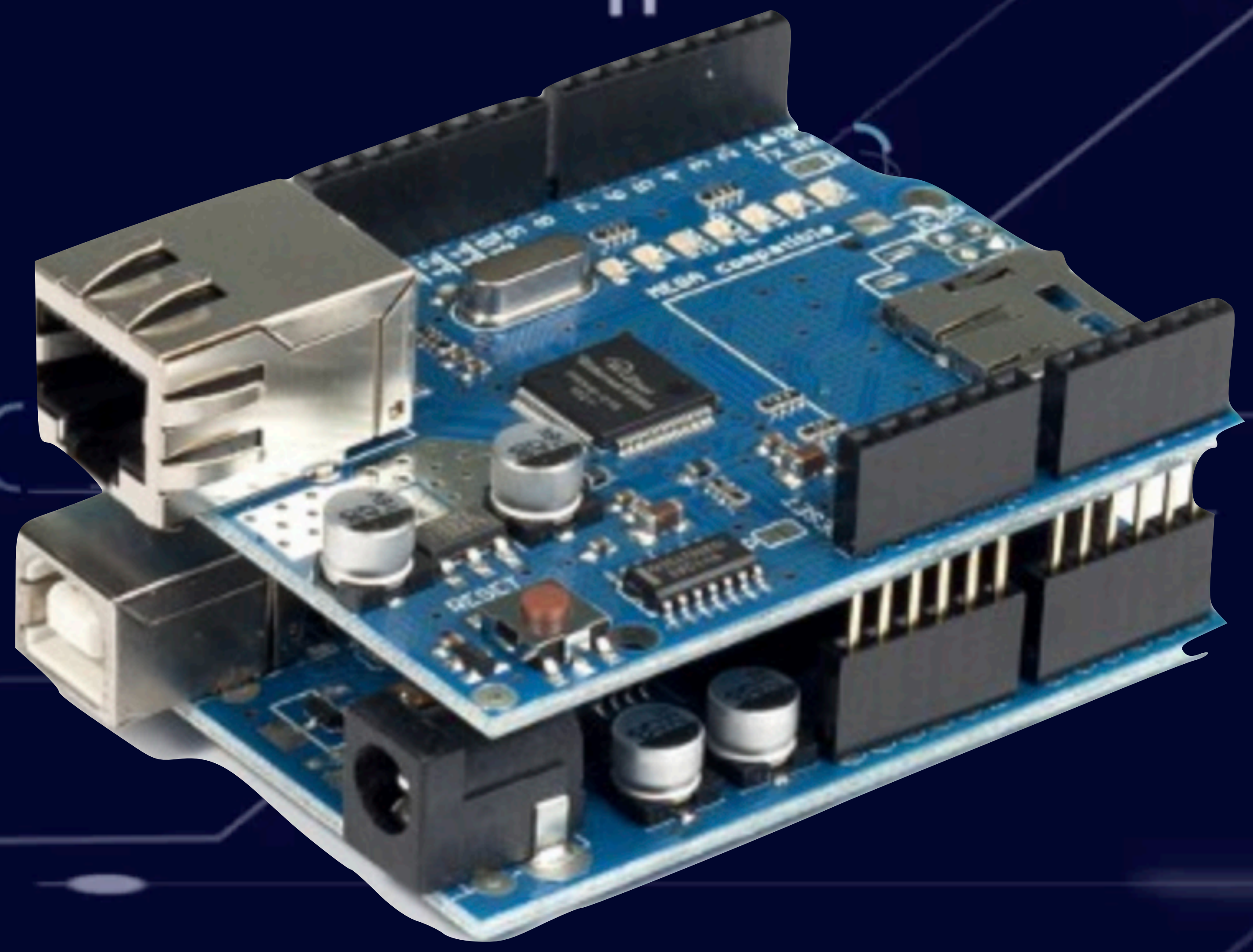
```
/*
  Blink
  Turns on an LED on for one second, then off for one second, repeatedly.

  This example code is in the public domain.
 */

// Pin 13 has an LED connected on most Arduino boards.
// give it a name:
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  digitalWrite(led, HIGH);   // turn the LED on (HIGH is the voltage level)
  delay(1000);               // wait for a second
  digitalWrite(led, LOW);    // turn the LED off by making the voltage LOW
  delay(1000);               // wait for a second
}
```

Image source: https://learn.sparkfun.com/tutorials/what-is-an-arduino/all

1972
1982
1999
2003

Arduino Ethernet

- Programmable device.
- Easily connectable.
- Open source.
- Simple to use software.
- Has network connectivity.



1972
1982
1999
2003
2012

Raspberry Pi

February 29th, 2012

- Computer.
- Linux inside.
- Programming oriented.
- Full network stack.

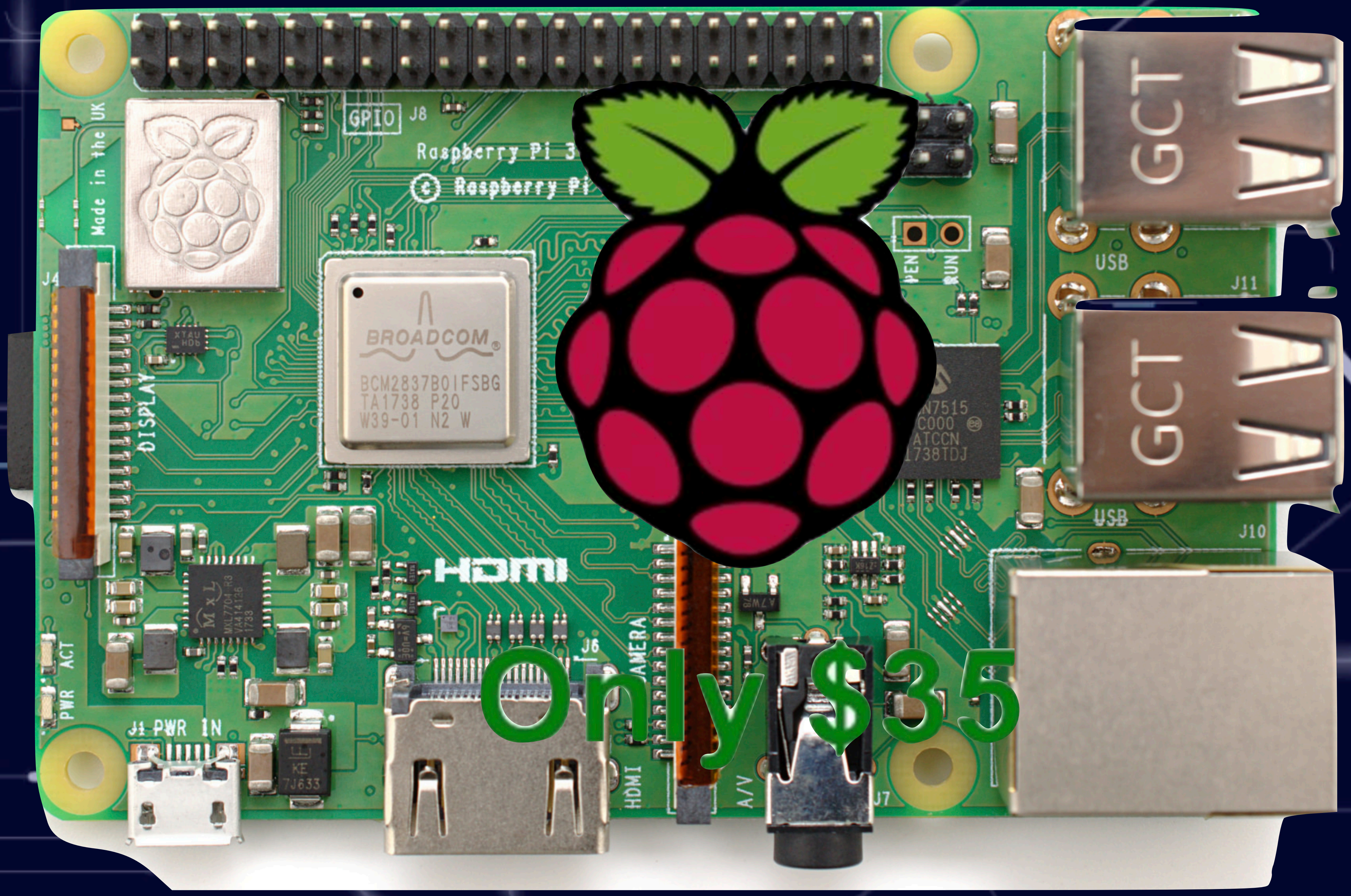
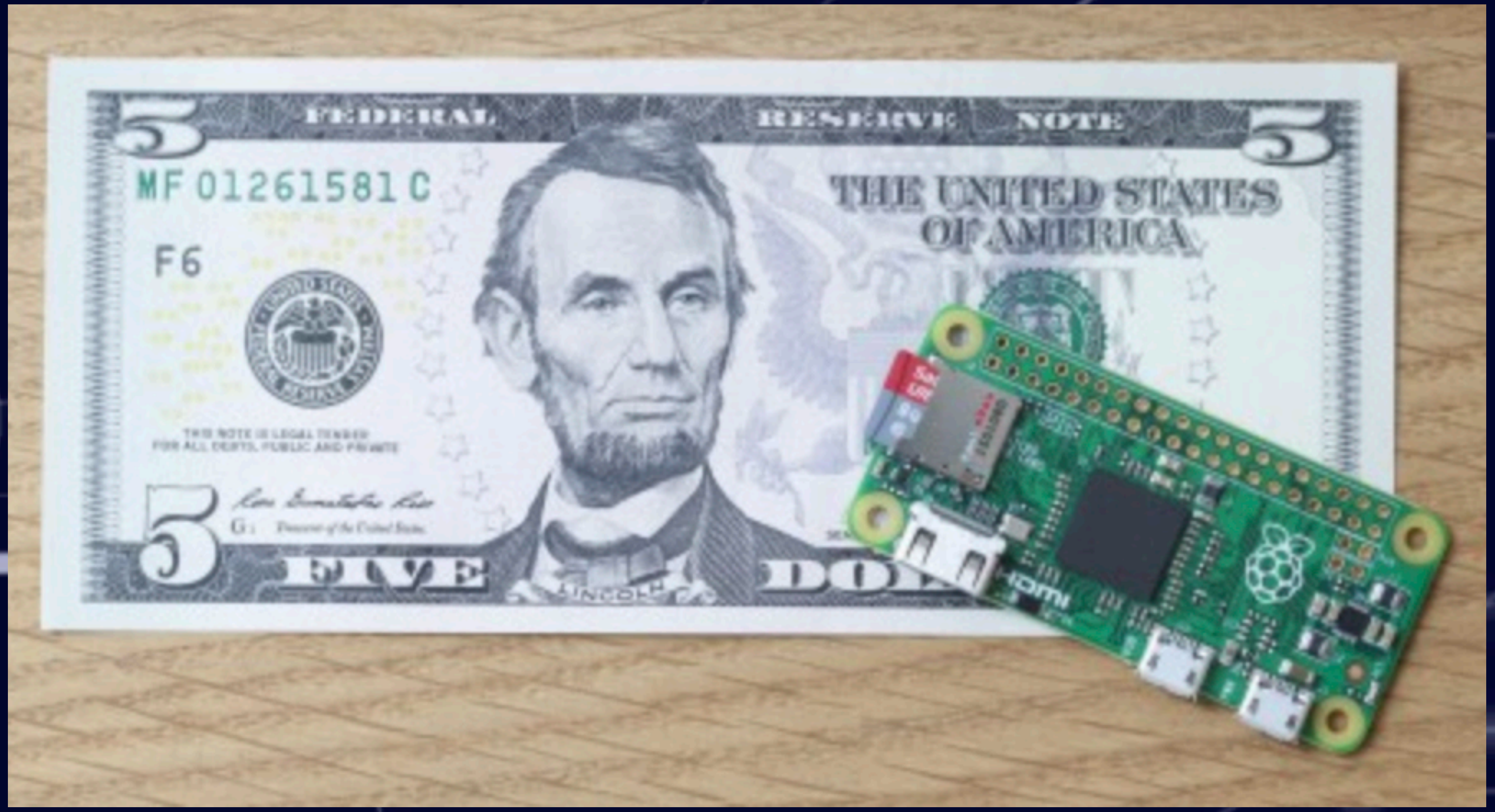


Image source: https://www.flickr.com/photos/120586634@N05/39906369025/

1972 1982 1999 2003 2012 2015

Raspberry Pi Zero

- A Broadcom BCM2835 application processor
- 1GHz ARM11 core
  - 40% faster than Raspberry Pi 1
- 512MB of LPDDR2 SDRAM
- A micro-SD card slot
- A mini-HDMI socket for 1080p60 video output
- Micro-USB sockets for data and power
- An unpopulated 40-pin GPIO header
- Small form factor, at 65mm x 30mm x 5mm

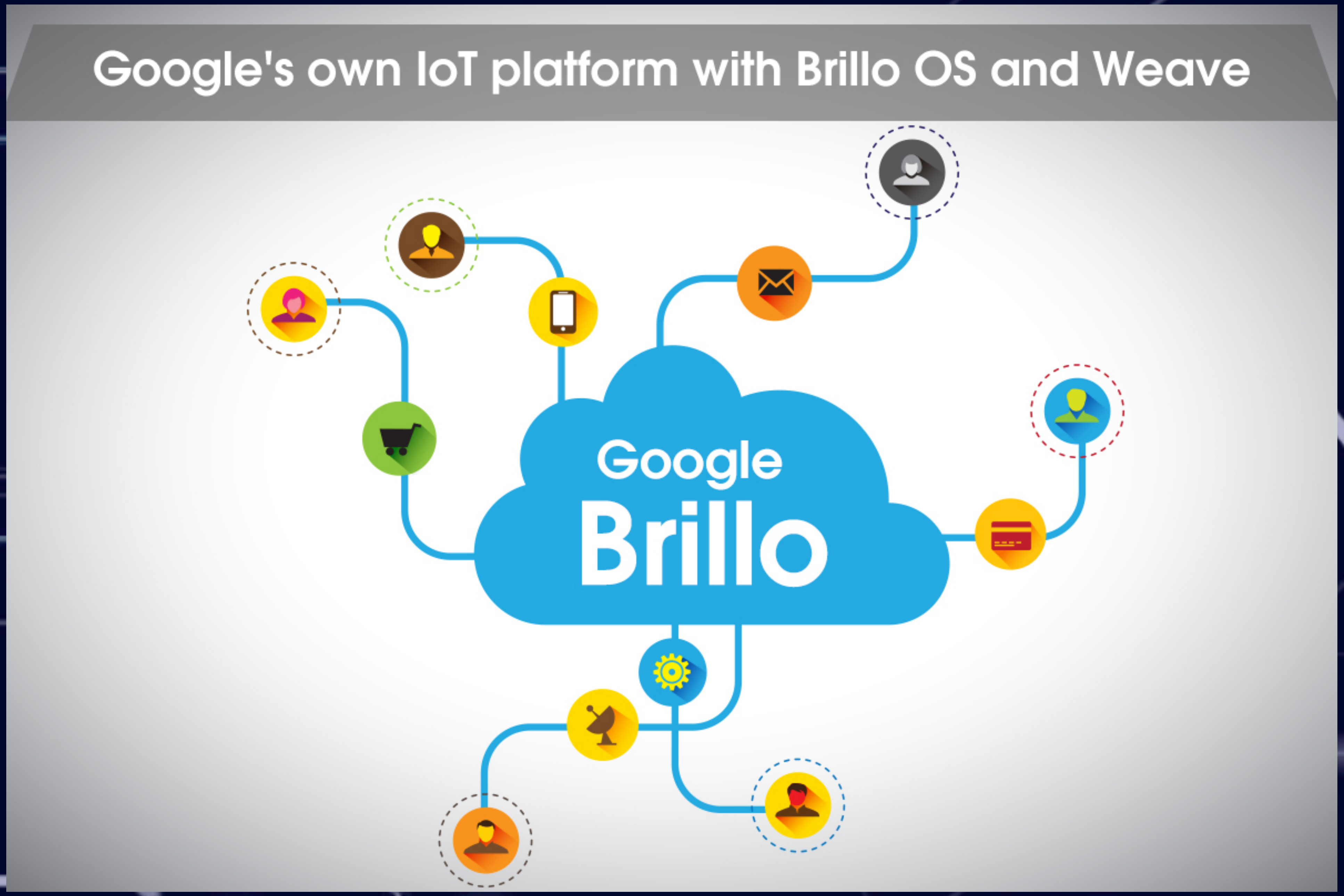


https://www.raspberrypi.org/blog/raspberry-pi-zero/

1972 1982 1999 2003 2012 2015 2018

Android Things

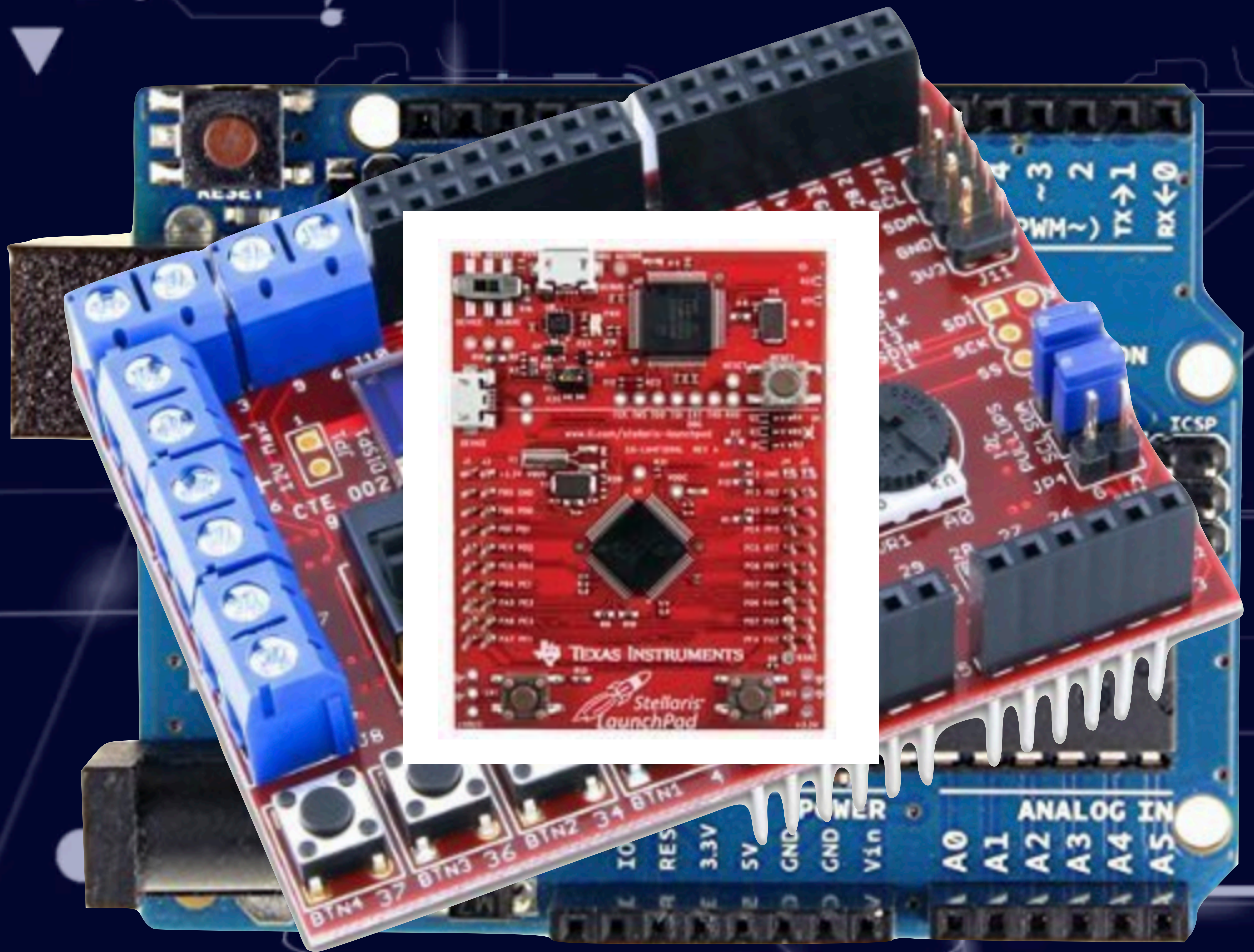
- Android Things lets you experiment with building devices on a trusted platform, without previous knowledge of embedded system design:
  - Develop using the Android SDK and Android Studio.
  - Access hardware such as displays and cameras natively through the Android framework.
  - Connect your apps with Google services.
  - Integrate additional peripherals through the Peripheral I/O APIs.
  - Use the Android Things Console to push over-the-air feature and security updates.



Google's own IoT platform with Brillo OS and Weave

https://developer.android.com/things

Good with Sensors

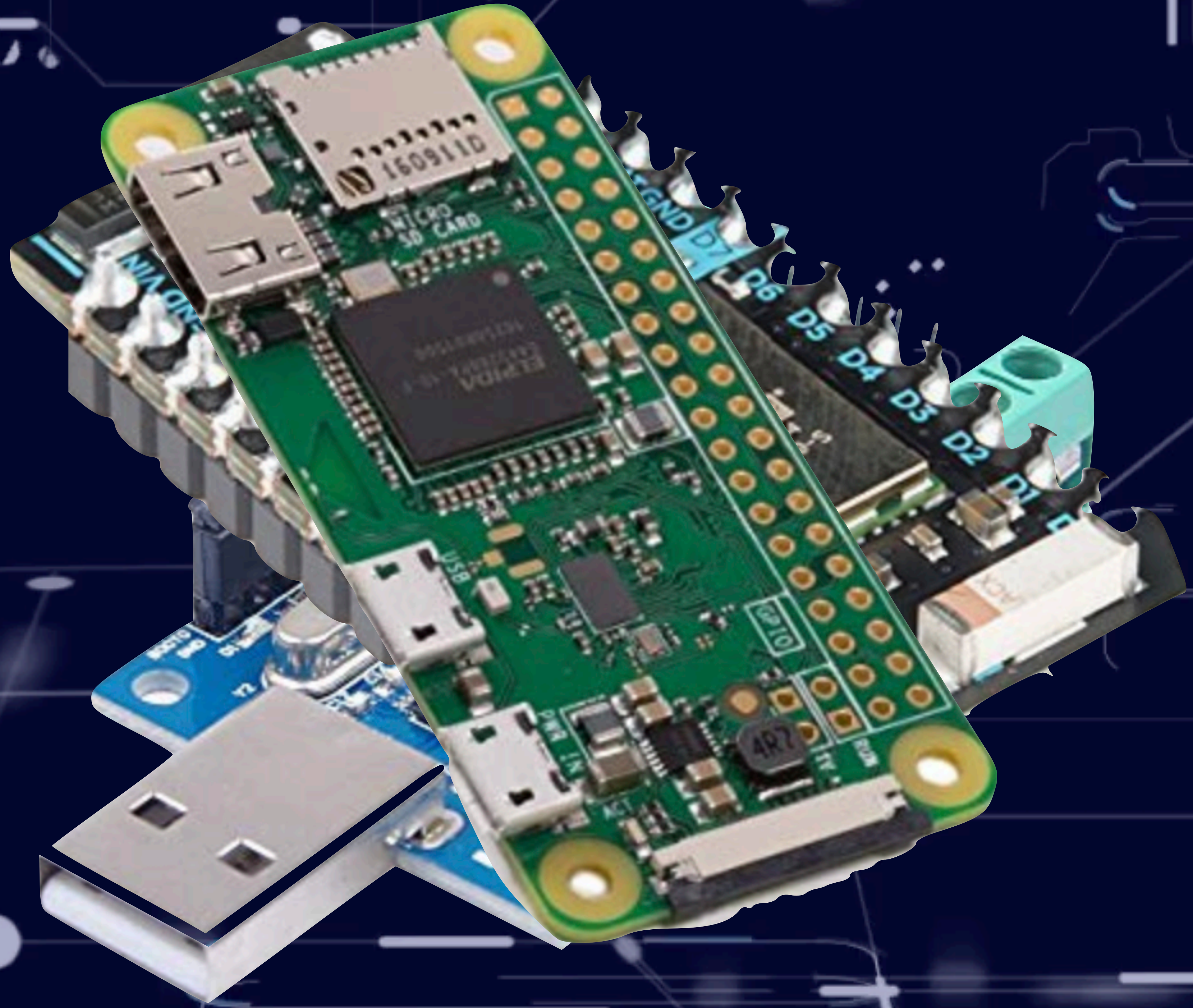


chipKLAUNCHPADShield

26$

ATLmega328P

Good with Sensors and for Processing

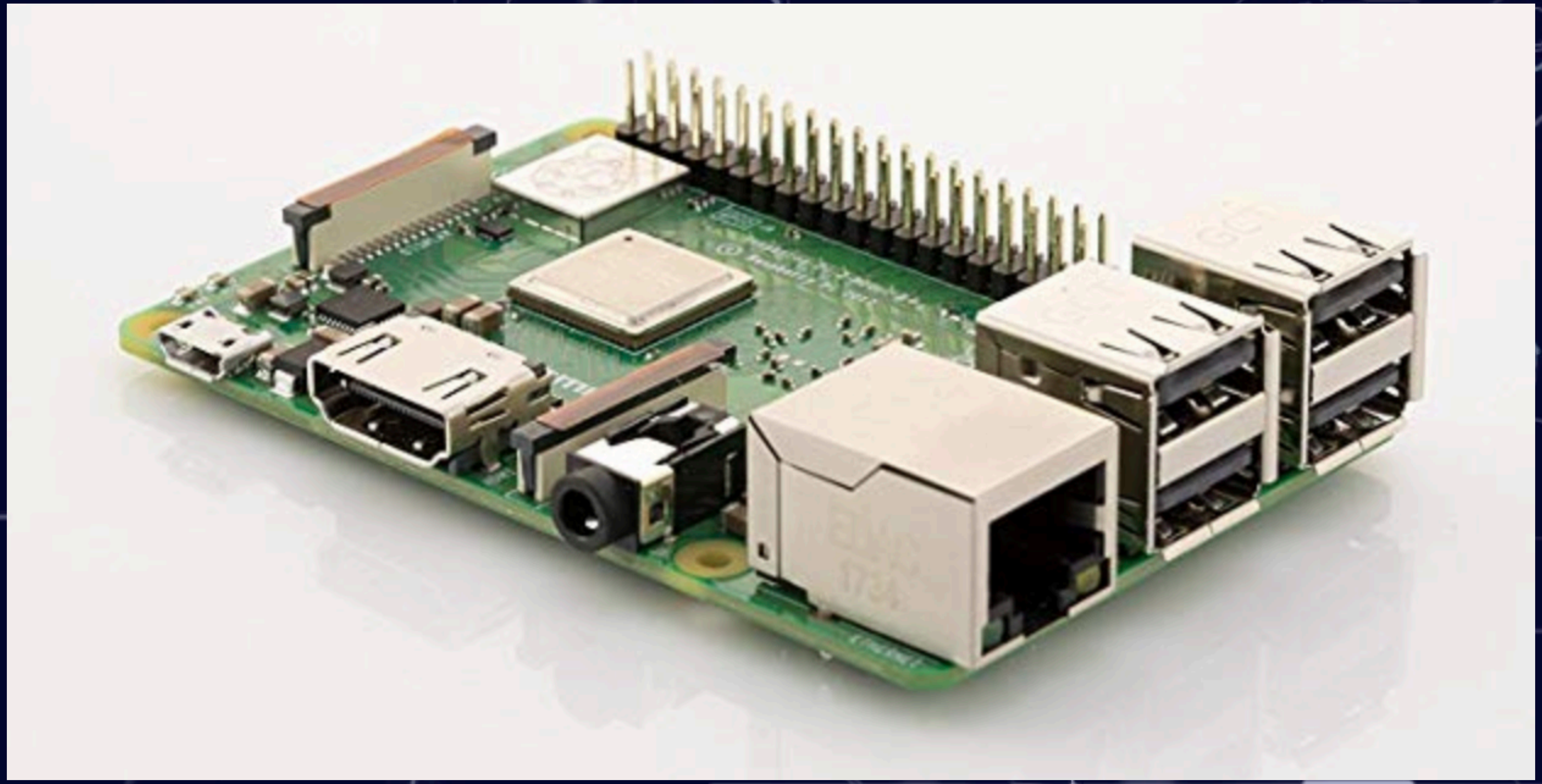


Raspberry Pi Zero [illegible]

[illegible]$

CH340 ARM [illegible] Module

Good for Processing and Network

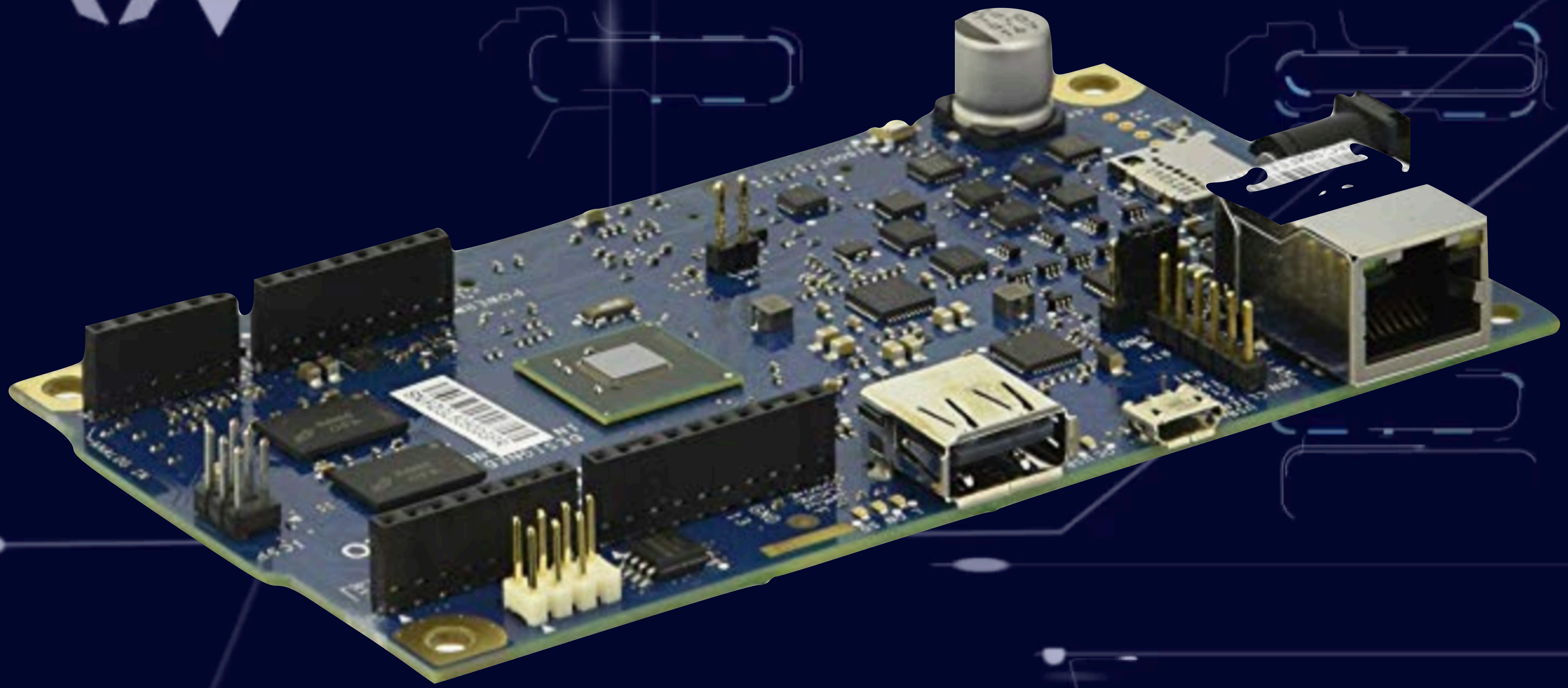


Raspberry Pi 3 B+

35$

ARM - 1GB RAM

Good for Processing and Network

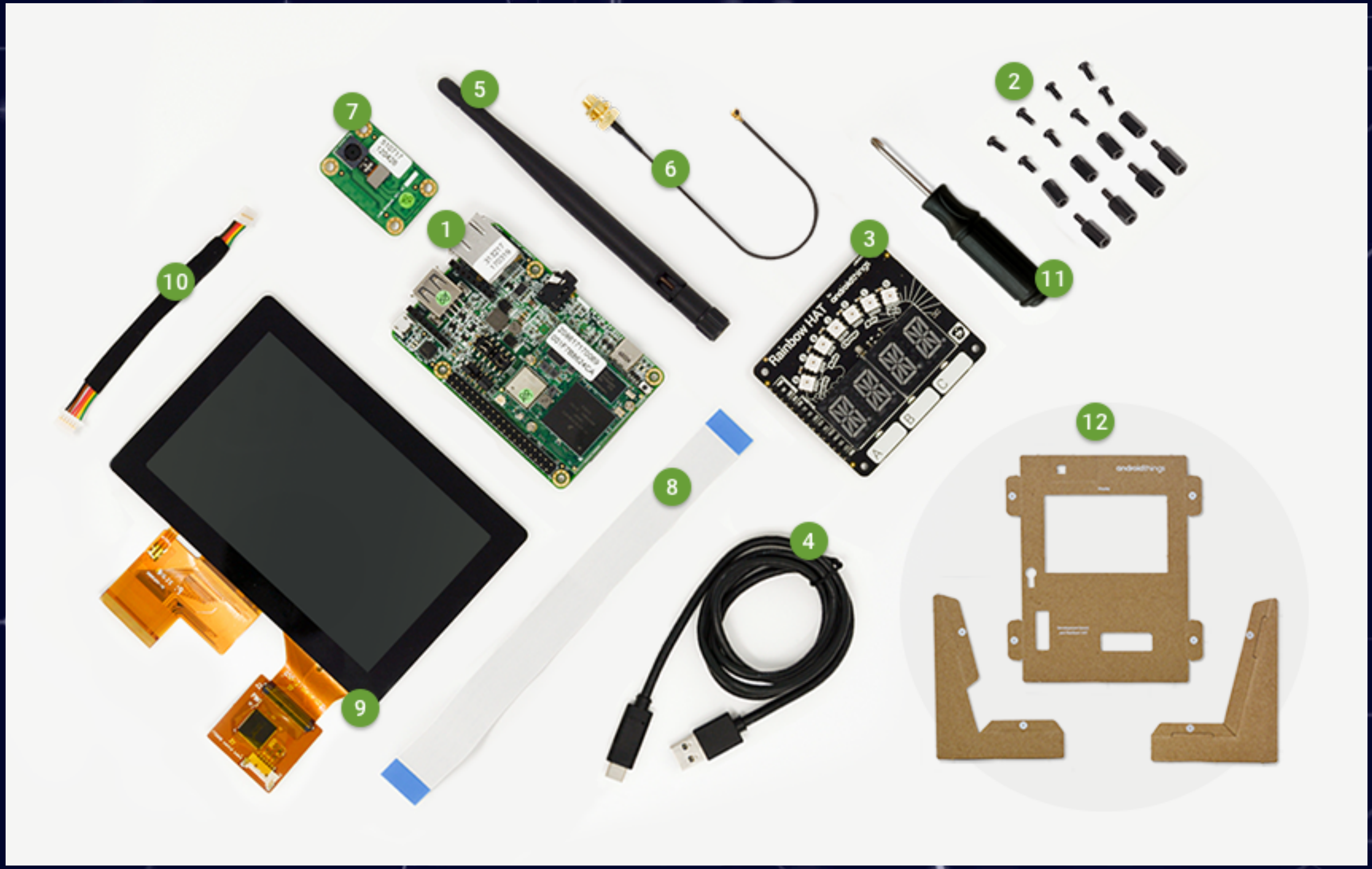


Intel Galileo Gen 2P

50$

Quark SoC - 400MHz - 256MB RAM

Android Things
NXP i.MX7D Starter Kit



ARM Cortex-A7 + M4

200$

https://shop.technexion.com/pico-pi-imx7-startkit-rainbow-hat.html

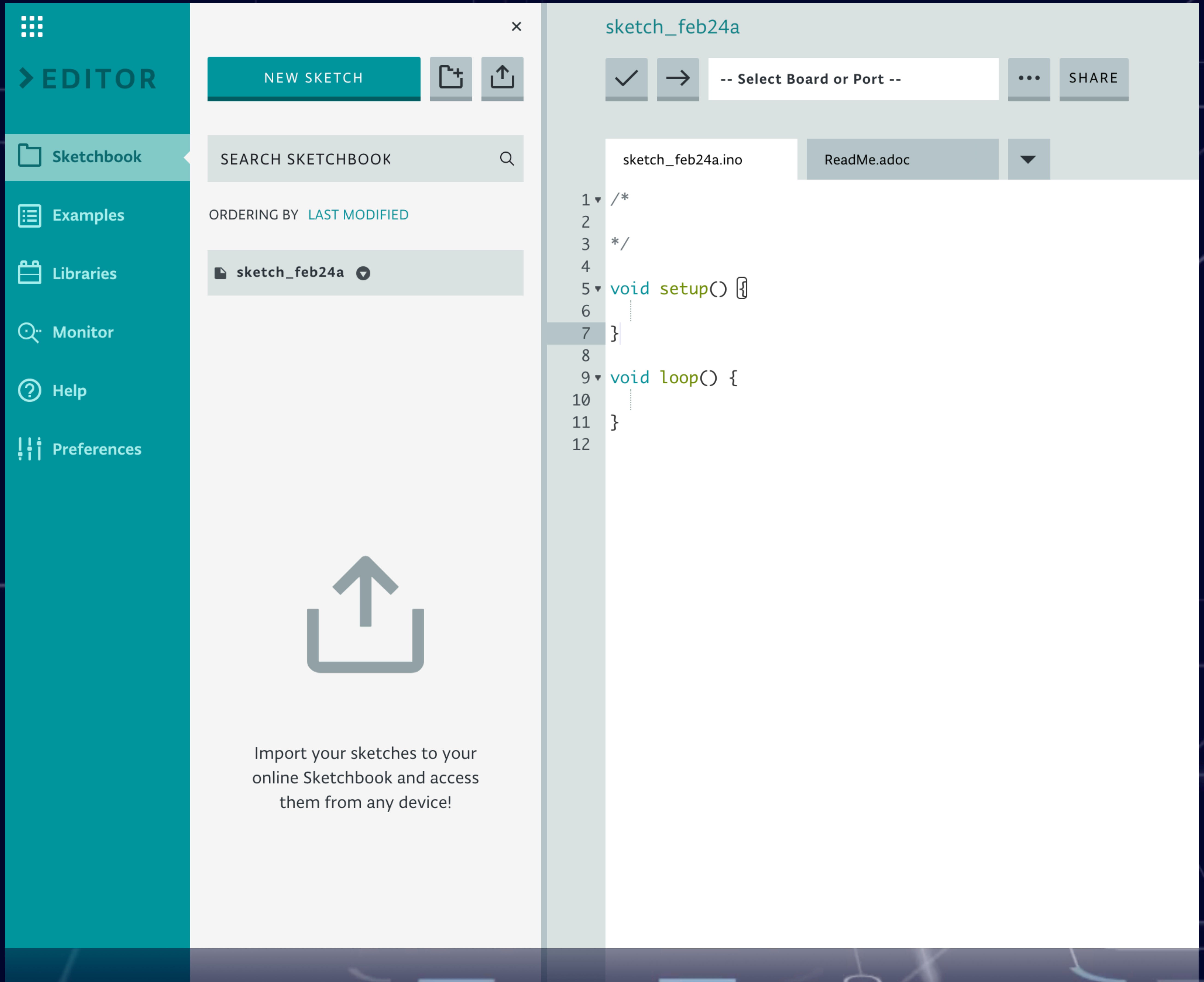
Android Things Raspberry Pi Kit

ARM Cortex A53

100$

https://androidthings.withgoogle.com/#!/kits/raspberry-pi-3-starter-kit

IDE Options

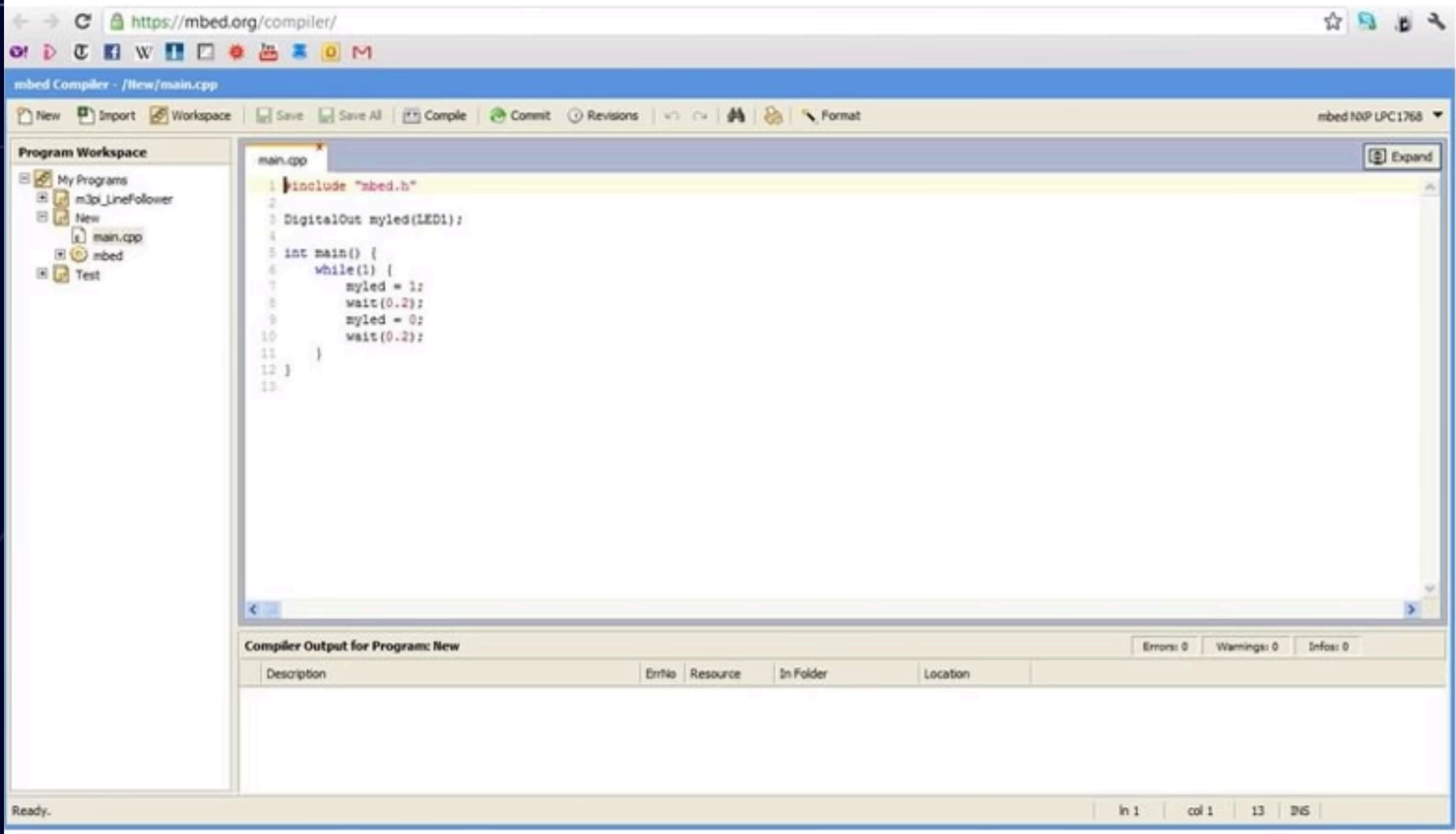


```
/*

*/

void setup() {

}

void loop() {

}

```

Import your sketches to your online Sketchbook and access them from any device!

https://create.arduino.cc

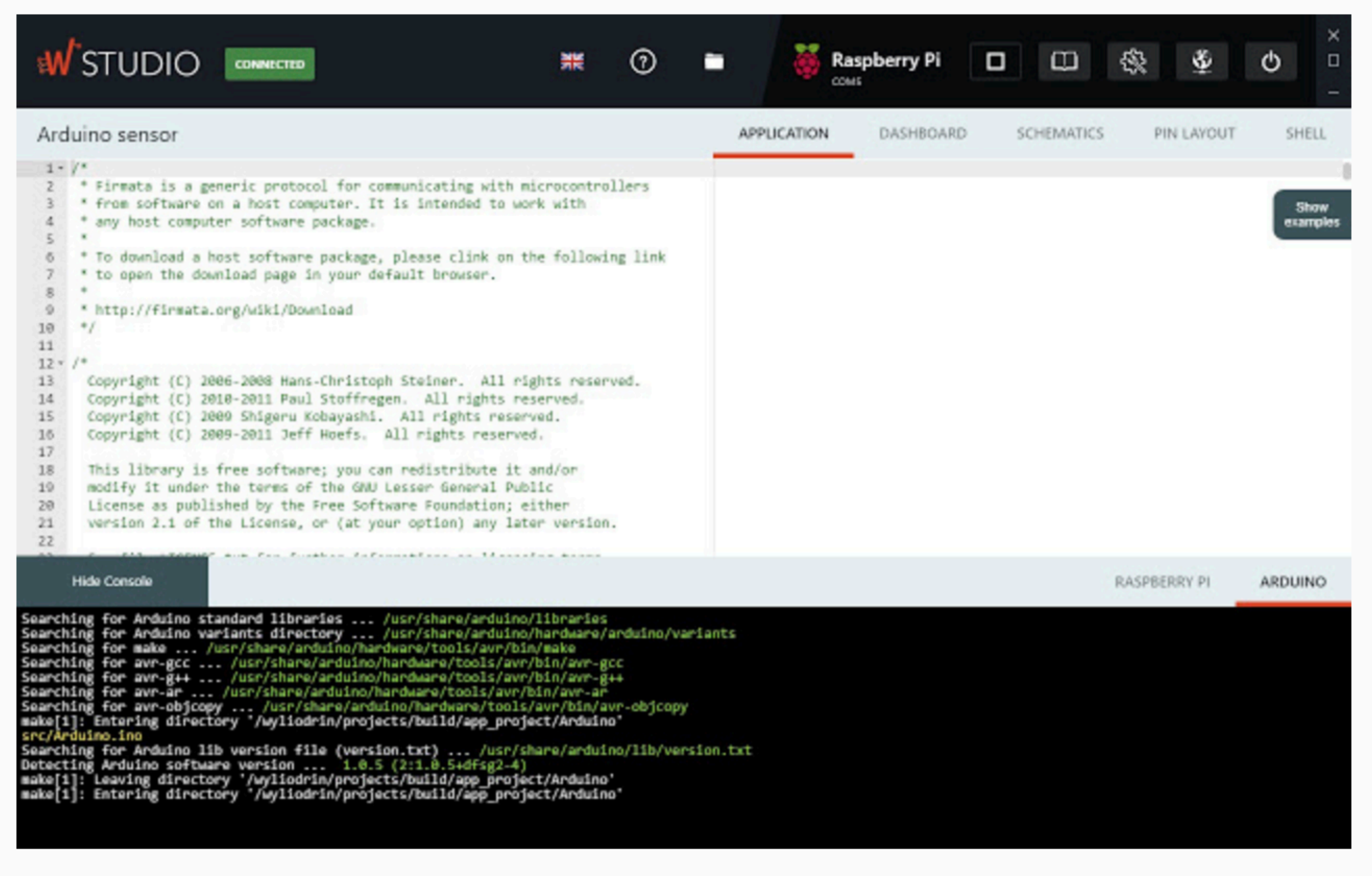
IDE Options



```
#include "mbed.h"

DigitalOut myled(LED1);

int main() {
    while(1) {
        myled = 1;
        wait(0.2);
        myled = 0;
        wait(0.2);
    }
}
```

https://os.mbed.com/

IDE Options

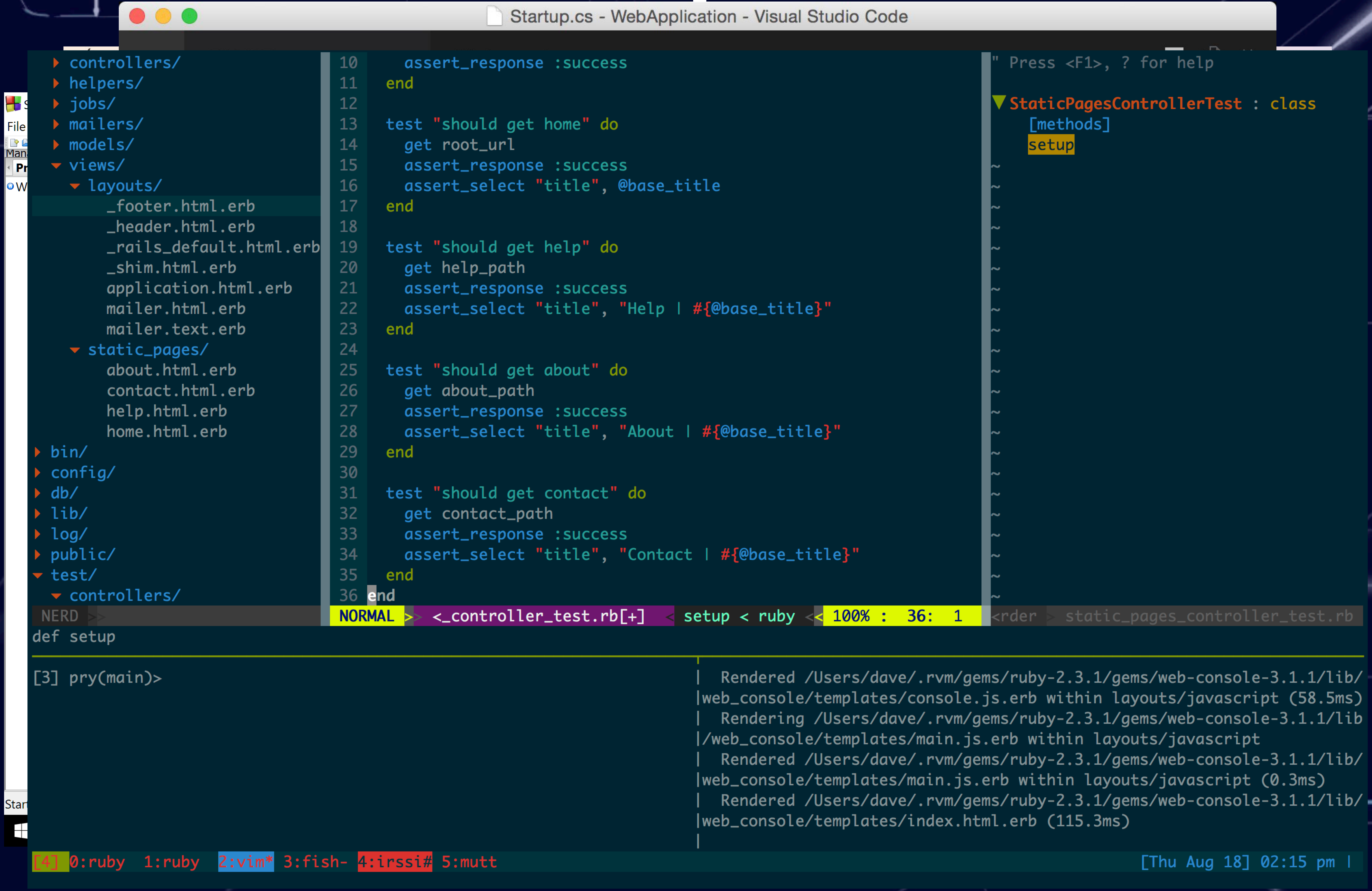


```
/*
 * Firmata is a generic protocol for communicating with microcontrollers
 * from software on a host computer. It is intended to work with
 * any host computer software package.
 *
 * To download a host software package, please clink on the following link
 * to open the download page in your default browser.
 *
 * http://firmata.org/wiki/Download
 */

/*
  Copyright (C) 2006-2008 Hans-Christoph Steiner.  All rights reserved.
  Copyright (C) 2010-2011 Paul Stoffregen.  All rights reserved.
  Copyright (C) 2009 Shigeru Kobayashi.  All rights reserved.
  Copyright (C) 2009-2011 Jeff Hoefs.  All rights reserved.

  This library is free software; you can redistribute it and/or
  modify it under the terms of the GNU Lesser General Public
  License as published by the Free Software Foundation; either
  version 2.1 of the License, or (at your option) any later version.

```

```
Searching for Arduino standard libraries ... /usr/share/arduino/libraries
Searching for Arduino variants directory ... /usr/share/arduino/hardware/arduino/variants
Searching for make ... /usr/share/arduino/hardware/tools/avr/bin/make
Searching for avr-gcc ... /usr/share/arduino/hardware/tools/avr/bin/avr-gcc
Searching for avr-g++ ... /usr/share/arduino/hardware/tools/avr/bin/avr-g++
Searching for avr-ar ... /usr/share/arduino/hardware/tools/avr/bin/avr-ar
Searching for avr-objcopy ... /usr/share/arduino/hardware/tools/avr/bin/avr-objcopy
make[1]: Entering directory '/wyliodrin/projects/build/app_project/Arduino'
src/Arduino.ino
Searching for Arduino lib version file (version.txt) ... /usr/share/arduino/lib/version.txt
Detecting Arduino software version ...  1.0.5 (2:1.0.5+dfsg2-4)
make[1]: Leaving directory '/wyliodrin/projects/build/app_project/Arduino'
make[1]: Entering directory '/wyliodrin/projects/build/app_project/Arduino'
```

https://wyliodrin.com/

IDE Options



```
 ▸ controllers/
 ▸ helpers/
 ▸ jobs/
 ▸ mailers/
 ▸ models/
 ▾ views/
   ▾ layouts/
       _footer.html.erb
       _header.html.erb
       _rails_default.html.erb
       _shim.html.erb
       application.html.erb
       mailer.html.erb
       mailer.text.erb
   ▾ static_pages/
       about.html.erb
       contact.html.erb
       help.html.erb
       home.html.erb
▸ bin/
▸ config/
▸ db/
▸ lib/
▸ log/
▸ public/
▾ test/
 ▾ controllers/
```

```ruby
    assert_response :success
  end

  test "should get home" do
    get root_url
    assert_response :success
    assert_select "title", @base_title
  end

  test "should get help" do
    get help_path
    assert_response :success
    assert_select "title", "Help | #{@base_title}"
  end

  test "should get about" do
    get about_path
    assert_response :success
    assert_select "title", "About | #{@base_title}"
  end

  test "should get contact" do
    get contact_path
    assert_response :success
    assert_select "title", "Contact | #{@base_title}"
  end
end
```

```
" Press <F1>, ? for help

▼ StaticPagesControllerTest : class
    [methods]
    setup
```

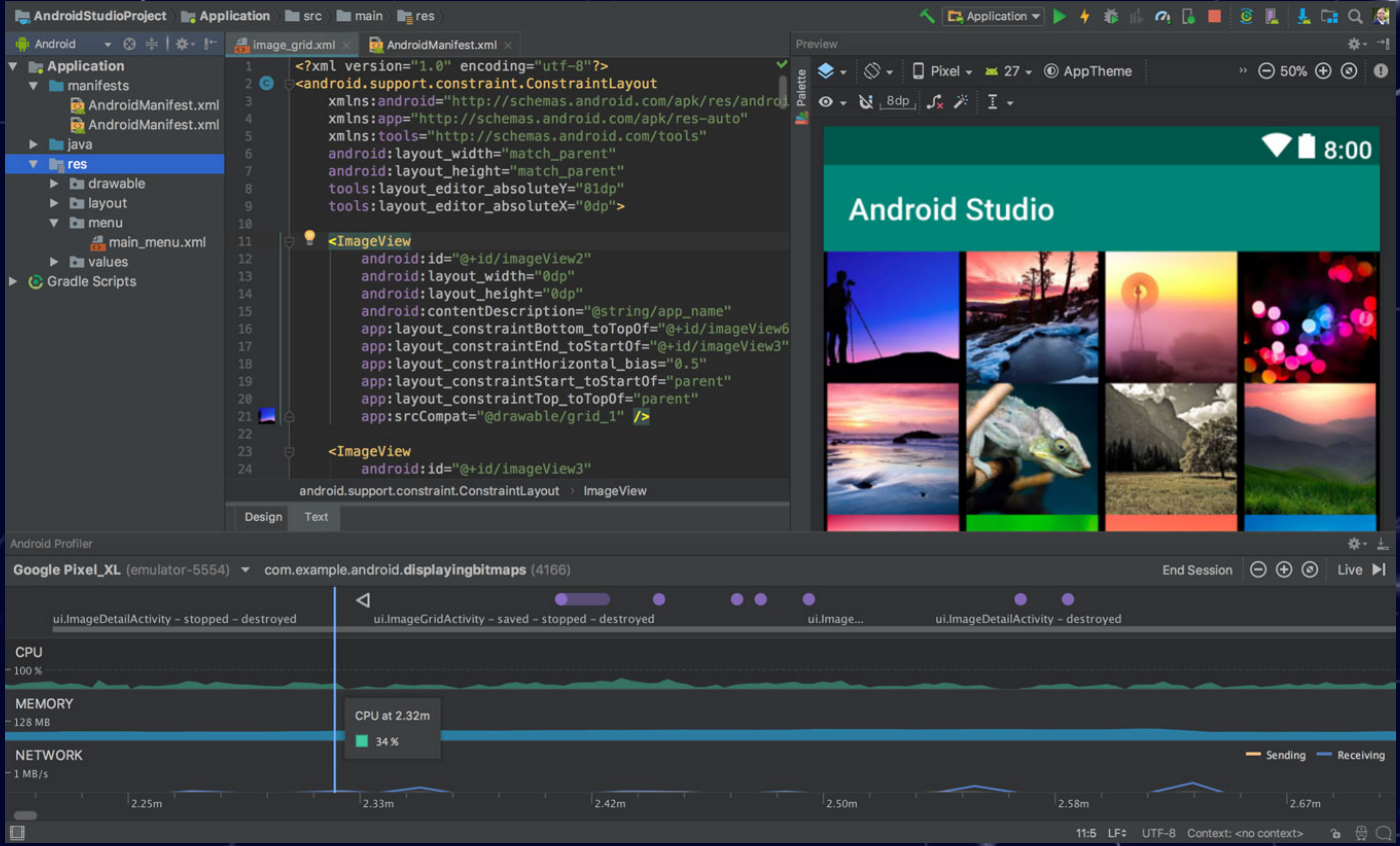
```
NERD    NORMAL > <_controller_test.rb[+] < setup < ruby < 100% :  36:  1   <rder > static_pages_controller_test.rb
def setup
```

```
[3] pry(main)>
```

```
|  Rendered /Users/dave/.rvm/gems/ruby-2.3.1/gems/web-console-3.1.1/lib/
|web_console/templates/console.js.erb within layouts/javascript (58.5ms)
|  Rendering /Users/dave/.rvm/gems/ruby-2.3.1/gems/web-console-3.1.1/lib
|/web_console/templates/main.js.erb within layouts/javascript
|  Rendered /Users/dave/.rvm/gems/ruby-2.3.1/gems/web-console-3.1.1/lib/
|web_console/templates/main.js.erb within layouts/javascript (0.3ms)
|  Rendered /Users/dave/.rvm/gems/ruby-2.3.1/gems/web-console-3.1.1/lib/
|web_console/templates/index.html.erb (115.3ms)
|
```

```
[4] 0:ruby  1:ruby  2:vim* 3:fish- 4:irssi# 5:mutt                              [Thu Aug 18] 02:15 pm |
```

IDE Options



```
<?xml version="1.0" encoding="utf-8"?>
<android.support.constraint.ConstraintLayout
    xmlns:android="http://schemas.android.com/apk/res/androi
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:layout_editor_absoluteY="81dp"
    tools:layout_editor_absoluteX="0dp">

    <ImageView
        android:id="@+id/imageView2"
        android:layout_width="0dp"
        android:layout_height="0dp"
        android:contentDescription="@string/app_name"
        app:layout_constraintBottom_toTopOf="@+id/imageView6
        app:layout_constraintEnd_toStartOf="@+id/imageView3"
        app:layout_constraintHorizontal_bias="0.5"
        app:layout_constraintStart_toStartOf="parent"
        app:layout_constraintTop_toTopOf="parent"
        app:srcCompat="@drawable/grid_1" />

    <ImageView
        android:id="@+id/imageView3"
```

https://developer.android.com/studio

Laboratory Projects

- Two projects:
  - Individual project - 60% of the final grade.
  - Team project - 40% of the final grade.

Image source:
http://inkawall.com

Individual Project

Image source:
http://ceelo.org/individual-leader/

- A project similar to the samples available here:
  - https://github.com/androidthings/doorbell/
- Or enhance an existing sample.

Individual Project

- A project similar to the samples available here:
  - https://github.com/androidthings/doorbell/
- Or enhance an existing sample.
- Due: **April 15th**.
- Deliverables:
  - The source code should be hosted in a github classroom repository.
  - A webpage presenting the project results, similar to:
    - https://github.com/androidthings/doorbell/
  - A short video presenting the results.

Image source:
http://ceelo.org/individual-leader/

Team Project

Image source:
https://www.contractingbusiness.com

- A team of 3 students to tackle a real-world problem.
- Either:
  - Choose an existing project proposed by the lab instructor.
  - Define a new one, together with the lab instructor.

Team Project

Image source:
https://www.contractingbusiness.com

- A team of 3 students to tackle a real-world problem.
- Either:
    - Choose an existing project proposed by the lab instructor.
    - Define a new one, together with the lab instructor.
- Due: **May 15th**.
- Deliverables:
    - The source code should be hosted in a github classroom team repository.
    - A webpage presenting the project results, similar to:
        - https://github.com/androidthings/doorbell/
    - A short video presenting the results.
    - A companion mobile app to manage the IoT app.

Lecture outcomes

- Understand the available hardware and software options.
- IDE options.
- Project details.